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JOURNAL

OF THE

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3655
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1931. VOL. LI. SERIES III.

LONDON:
Published by THE ROYAL MICROSCOPICAL SOCIETY,
B.M.A. HOUSE, TAVISTOCK SQUARE, W.C. 1.

MADE AND PRINTED IN GREAT BRITAIN BY WILLIAM CLOWES AND SONS, LIMITED,
DUKE STREET, STAMFORD STREET, LONDON, S.E. 1.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

MARCH, 1931.

TRANSACTIONS OF THE SOCIETY.

PRESIDENTIAL ADDRESS.

I.—ADAPTATIONS IN CELL STRUCTURE. 575. 22.

By R. Ruggles Gates, M.A., Ph.D., LL.D.

(*Delivered January* 21, 1931.)

Three Plates and Three Text-Figures.

My address is on the subject of structural adaptations in cells, a topic which is at the same time biological and microscopical, and appears therefore to be a suitable one for the interests of this Society. Before beginning, however, I should like to make some reference to the work of the Society during the past year. I do not propose to do so at any length, but there are certain outstanding events and changes in the Society to which reference must be made. I should add, in passing, that several of our Fellows have unfortunately died, including Mr. B. B. Woodward, the well-known malacologist and bibliographer, who was elected a Fellow in 1880 and was for many years Librarian of the Natural History Museum; and Colonel J. W. Gifford, elected in 1892, an astronomer greatly skilled in the computation of lenses.

The May meeting of the Society was a special one devoted to microscopy in connection with metallography. It was held in the Great Hall at King's College, and was accompanied by an extensive series of exhibits which lasted throughout the day.

Perhaps the most important event in the history of the Society for many years was the removal from 20, Hanover Square, to its present palatial quarters in the British Medical Association House in Tavistock Square. In this connection I ought to refer to the heavy work which has devolved chiefly upon the Secretaries in making this change, and I feel deeply indebted to them and to all members of the Council for the support they have given me throughout the past year. One cannot but feel that the Society has not only considerably enhanced its status, but has increased its possibilities for future service to microscopical science. The facilities now available as regards meeting room, council room, offices, library, slides and the historical collections of microscopical instruments and apparatus, are such that the Society should experience a period of increased activity and steady growth. It is necessary to point out, however, that the rooms at Hanover Square will remain a burden on the funds of the Society during the greater part of this year. Hanover Square was the home of the Society from 1889 until last year, and I was interested to learn, in preparing this address, that during the previous period of thirty-three years, from 1856 to 1889, it had occupied rooms at King's College.

In the early years of the Society, after its foundation in 1840, the biological aspects of microscopy occupied the chief attention, and it was only in later decades that the Society attained primacy in connection with the development and history of the microscope. While the optics of the microscope will no doubt continue to be one of the major interests of our work, yet it is natural to hope that in its new environment the Society will receive an accession of numbers from the numerous men of medical attainments who are interested in microscopy. Owing to its presence in the neighbourhood of the now developing Bloomsbury site of the University of London, it should also receive increased support from professional biologists in London and, we hope, throughout the world. We may now fairly look forward to a long period of increasing usefulness for the Society, but it is necessary to emphasise the need for a larger membership. Modern science has become so technical that few amateurs can devote the necessary time to the mastery of a particular branch of microscopy and the production of important contributions to knowledge. We must look increasingly to professional scientists, whether in biology or in physics and chemistry, for support and contributions both at the meetings of the Society and to its Journal. At the same time the contributions of amateurs who can afford the time are doubly welcome. The Journal, since it was remodelled in 1927, serves as an admirable medium of publication, having also a wider circulation throughout the world than many well-known scientific journals.

The closer relations now rapidly developing between biologists, physicists, and chemists as the result of the intensive study of colloids, membranes, fibres, enzymes and similar bodies, should be reflected in our programmes. Fellows on the physical side, whose prime interest is in the working and improvement of the microscope, will also find plenty of problems where

physical knowledge is necessary in connection with such fields of investigation as those to which I have just referred. Their active help in the solution of such problems has already been of the greatest value. The discussions recently arranged and published by the Faraday Society on colloid science applied to biology show the importance of such co-operation between the physical and the biological sciences. One may justly say that while biology maintains, perhaps with increasing emphasis, its characteristic point of view, yet the methods of research of physics and chemistry are increasingly adopted in the analysis of organic structure and function. This remark receives emphasis, not only from the development of biochemistry but still more from the naissance of its younger sister, biophysics.

If I may return for a moment to the early history of the Society, it is interesting to note that its first President was Richard Owen, Hunterian Professor at the Royal College of Surgeons, later to become Director of the Natural History Museum and one of the chief opponents of Darwin. The first paper in the Society's Journal was by E. J. Quekett, on the development of the vascular tissue in plants. The cell theory of Schleiden and Schwann, which had recently been promulgated, dominated his observations, and reference is also made to Robert Brown's discovery, which had taken place in 1831, of the nucleus as a structure present in every cell.

It is worth noting that in 1841 Michael Faraday became a Fellow. Other early members included Professors John Lindley (of University College), Rymer Jones, Arthur Farre, Thomas Bell, Edward Forbes * and Jeffrey Bell (all of King's College), several of whom were afterwards Presidents of the Society. In 1853 Wheatstone first contributed to the Journal. Dr. W. B. Carpenter was President in 1854–5, and in 1857 Huxley became a member of Council. Dr. Edwin Lankester edited the Journal for eighteen years (1853–71), and became President 1858–9. His eminent son, Sir Ray Lankester, was elected in 1865 and served as President in 1909. Presidents of note among his immediate predecessors were Dr. D. H. Scott (1904–06) and Lord Avebury (1907–08). In 1880 Professor Lionel Beale (of King's College) was President, and devoted his address to a discussion of the nature of living matter. He held extreme vitalistic views, but his criticisms of Huxley were justified when he emphasised the difference between living and dead organic matter. Huxley's theory of Bathybius, based on dredgings from the Atlantic which were supposed to represent masses of formless protoplasm on the sea bottom, also came in for destructive criticism.

These names, and many more which might be mentioned, show that the Society has taken a leading part in the history of biology in this country, although the multiplication of scientific societies in recent decades has made it more difficult for all who would wish to do so to join the Society.

* Edward Forbes was one of the leading naturalists of his time. His work is referred to in the "Origin of Species." He was Professor of Botany at King's College, London, 1842–1855.

Coming now to the subject of my address, I decided to leave aside on this occasion the modern intensive work on nuclear structure and chromosomes, which has rapidly become the basis of genetical investigations. Instead I have chosen to consider to-day the neglected field of structural adaptations in cells. I do this because such structures are frequently before the attention of Fellows of the Society, but biologists in recent years have generally neglected any comparative study of their significance. Even evolutionary students of adaptations usually pay little attention to this amazingly interesting field of investigation, confining themselves mainly to adaptations involving whole organs or groups of organs in animals or plants.

I shall confine myself chiefly to cellular adaptations in plants, but these conditions in the Protozoa reach such an extreme development that one may refer briefly to one or two cases. Diplodinium is found, together with other genera of Protozoa, in the stomachs of cattle and other ruminants. R. G. Sharp (1914) has made a detailed study of *D. ecaudatum*, observing them in living cultures and also from microtome sections. Within the single cell is displayed a complexity as great as that of many multicellular organisms, if we think of the differentiation of function involved. A few of these specializations may be mentioned. The cuticle which covers the body is specialized in three areas. The ectoplasm contains "skeletal areas," an oral cavity, cytostome or mouth and œsophagus, lips, discs and operculum, cæcum, rectum and anal opening. The endoplasm shows certain lines of streaming and is more or less homogeneous in appearance, but contains food particles in vacuoles. Thus the "alimentary canal" is completed within a single cell. The micronucleus and macronucleus are also present, as well as anterior and posterior contractile vacuoles. On the outside are dorsal and adoral clumps of cilia, the cilia in each tuft adhering like the hairs of a camel-hair brush. Membranelles, flapping or swinging membranes, are formed by the fusion of two or more rows of cilia, and oral cilia are also present. Finally we may mention the so-called neuromotor apparatus, consisting of a motorium or centre of motor influences, dorsal and ventral motor strands, an adoral lip strand, opercular and œsophageal fibres, and, perhaps most remarkable, a circum-œsophageal ring. The membranelles can move independently, and must therefore be supplied by separate "nerve fibres."

This unicellular organism has differentiated parts in connection with the functions of ingestion, digestion, and egestion of food, an elaborate series of specializations for movement of the cell as a whole and of its various parts—a neuromotor apparatus—as well as a stiffening "skeleton" and a protective cuticle. One may suppose that evolution has taken at least as long to produce such an organism as to produce a hydra on a multicellular basis. It is comparable with a Rotifer both in size and complexity.

Yocum (1918) has found almost equal complexity in *Euplotes patella*, and

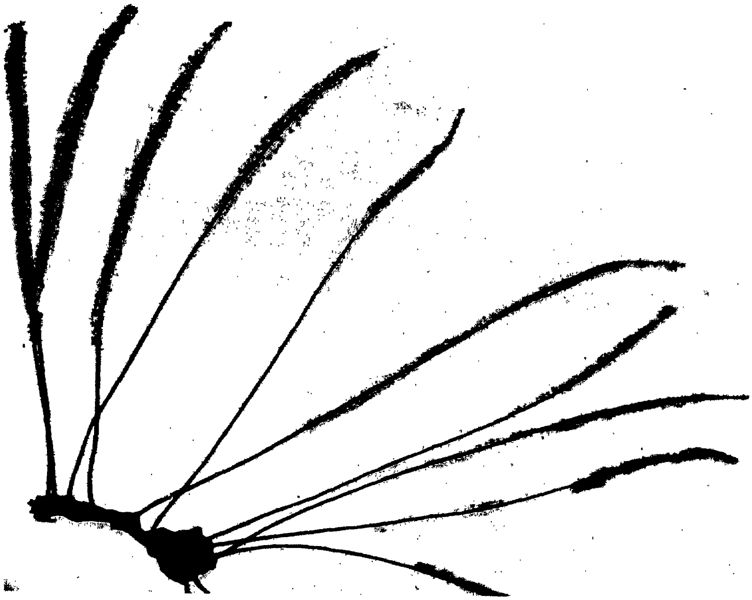

FIG. 1.

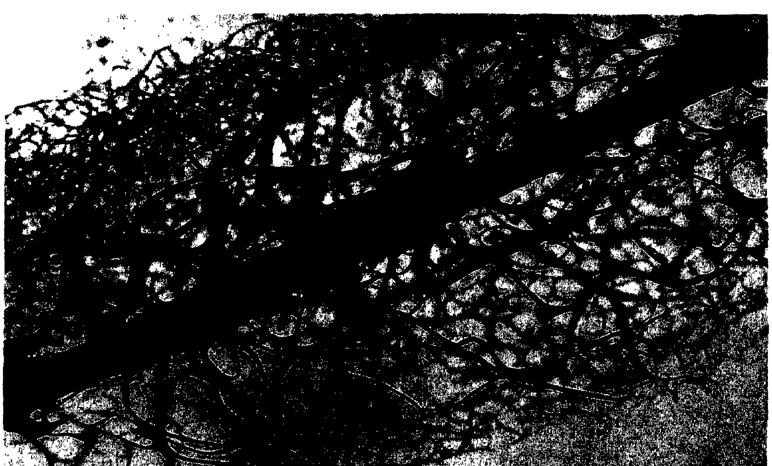

FIG. 2.

Face p. 4.

Rees (1921) demonstrated in Paramecium a corresponding set of neuromotor fibres. From the neuromotor centre in Paramecium radiate a series of fine branching fibres to the periphery and the membranelle of the cytopharynx. The peripheral fibres are connected to the basal granules of the cilia, and also to the trichocysts. They are in two whorls, one on the oral and one on the aboral side. By micro-dissection it was shown that when the neuromotor fibres are cut, the co-ordination of movement in the membranelles is interrupted, and when further damage is done around the neuromotor centre, the co-ordination of the peripheral cilia is destroyed. However these remarkable structures may have arisen, they are all examples of structural adaptations in cells.

Innumerable interfaces are present in such cells, without any interaction leading to the alteration or breakdown of the structures present. Moreover, none of these structures, unless it be the "skeletal" elements, has a consistency denser than that of a gel.

One further remarkable case of specialized adaptation in Protozoa may be mentioned. Dogiel (1924) has described conjugation in *Cycloposthium bipalmatum*, which lives in the intestine of the horse. The male pronucleus is actually transformed into a spermatozoon complete with a head having a perforatorium, and a tail. While the two conjugants are attached by their oral surfaces, the single sperm from each conjugant passes across and finds its way down the mouth and pharynx of the other conjugant, to unite finally with the female nucleus. One must therefore conclude that a structure with all the essential paraphernalia of a sperm for movement and penetration has developed here in the Protozoa quite independently of its evolution in the Metazoa. Similarly, the remarkable resemblance between the flagellate *Trichomonas angusta* and the sperm of the toad *Bombinator igneus* has been pointed out by Alexeieff (1923).

Cilia are structures common to many plant and animal cells. However they may differ in matters of length, thickness, and other details, they all apparently agree in the general features of their structure and rhythmic movement, the blepharoplast granules of plant spermatozoids corresponding with the basal granules of ciliated epithelium. Even although the huge multiciliate spermatozoids of Cycads may be traced back to an aquatic ancestry in the Flagellates, yet one must assume that the ciliated condition of various animal tissues has arisen independently. This is a widespread adaptational condition of the cell, the many types of cilia and flagella being adjusted in structure to the particular functions they have to perform. Although many flagella are compound, yet the elements of which they are composed appear to be universally similar in structure. Gray (1930) has recently made a cinematographic study of the ciliary movement in Mytilus, demonstrating many interesting features of the ciliary beat, but apparently without as yet throwing further light on the fundamental structure of the cilium.

Reference may be made to one other feature common to plant and

animal cells, namely, the *mitotic mechanism*. From an evolutionary point of view this must, I think, be regarded as an adaptational mechanism, which has reached a high state of perfection in the higher plants and animals, although we see various simpler stages of its development among the Protista and allied groups. Much has still to be learned of the evolution of this mechanism among lower organisms, but the fact that it is present in primitive form in such genera as Amœba, Plasmodiophora, and the Cyanophyceæ, shows that it was evolved very early. Indeed, its existence in sufficiently developed form to bring about an accurate division and distribution of all the chromatin elements has evidently made possible the evolution of higher multicellular plants and animals. We must suppose that in an organism as simple as an Amœba there is relatively little differentiation of the chromosomes and their parts. But the possibility of perpetuating any amount of later chromatin differentiation was already present, once the mitotic figure in its simplest form had been evolved.

This appears to be a case where a particular mechanism is developed long before evolution is able to make more than a limited use of it. If the gene theory of chromosome structure has any basis in fact—and the evidence is very strong—then much evolutionary differentiation (I do not say all) has taken place as the result of mutational gene differences arising in the chromosomes and perpetuated by the mechanism of mitosis. From this point of view we may think of evolution as consisting in part in the exploitation of the possibilities of nuclear species-differentiation and the perpetuation of the resulting types by this mechanism, each species having its characteristic nuclear type. The production, by variations not multiform but following a determined direction, of a structure or mechanism which only comes to function at a later period, has been called by Berg (1926) nomogenesis. He cites many supposed cases in plants and animals, some of them real and some probably imaginary. The mitotic mechanism would fit only partly into this conception, because it is of use in every stage of its evolution, and its importance has gone on increasing with the increase of differentiation within the nucleus. It is possible that the mitotic figure has evolved independently more than once. At any rate, the differences between mitosis as seen in higher plants and animals show that the later stages in its evolution have been different in the two groups, although both are equally efficient as regards the function of dividing and distributing the chromosomes.

In plants the specializations and adaptations of cells are concerned chiefly with the cell wall. They are therefore not strictly protoplasmic, but are rather to be regarded as products of the activity of the protoplasm. Spiral and annular markings are familiar structures in the walls of plant cells. They occur in such diverse elements as the capillitium of Mycetozoa, the elaters of Liverworts, the velaminous layer of some aerial roots, the walls of the sporangia in Equisetum, Ginkgo, and Abietineæ, and in the xylem tracheids of vascular plants.

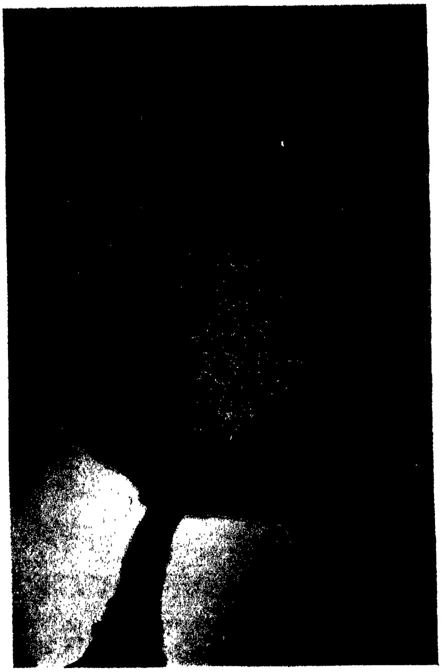

FIG. 3.

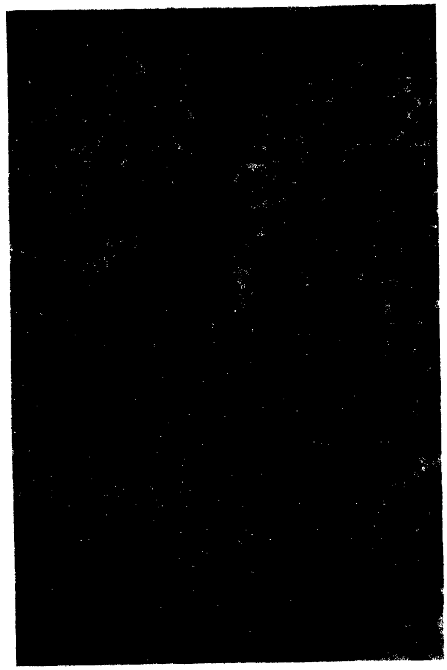

FIG. 4.

FIG. 5.

FIG. 6.

Face p. 6.

Let us consider for a moment the *capillitium* of the Mycetozoa. These structures undoubtedly aid in the dispersal of the spores, but they take a great variety of forms in the group, sometimes definite elaters with spiral markings, sometimes a simple basket-work of smooth threads taking various shapes (figs. 1–3). The process of capillitium formation in certain typical Mycetozoa has been studied in some detail by Harper and Dodge (1914). The formation of threads in the plasmodium is initiated by the liberation of water, thus forming elongated vacuoles whose surfaces constitute the original walls of the elater-like structures. The vacuolar sap contains substances in solution which later probably furnish materials for the capillitial wall. The spirals are laid down on the *outside* of the thread, next to the vacuolar membrane, evidently through the activity of the surrounding protoplasm (see fig. 4). In species such as *Hemiarcyria clavata* the spiral is clearly a left-handed one.

Taking the group as a whole, we find a great variety of form and many degrees in the perfecting of these structures. But at present we are wholly unaware of the mechanism in the protoplasm which brings about the deposition of these spiral bands. In Liverworts, as we shall see, the spirals are laid down inside and not outside the cell wall. Some rhythmic process in the protoplasm must determine the spiral arrangement in all. We shall examine this again in the case of xylem formation. In such Mycetozoa as Badhamia the capillitium is relatively crude and ineffective. How the Trichiaceæ have learned to form their beautiful and more highly efficient capillitium (fig. 5) we do not know. We can only ask: Will the selection of chance variations account for them? What has been selected and developed is evidently some rhythmic or repetitive quality in the cytoplasm which determines the laying down of the spirals. However these structures may have arisen, we find also in the Gastromycetes a capillitium having similar functions in spore dispersal, but composed of smooth threads (fig. 6) which must have evolved quite independently in this group.

The *elaters* of Liverworts form an interesting and extensive comparative study in themselves. Their whole evolution is obviously quite independent of that we have seen in the Mycetozoa. They arise in an entirely different way, and again we find many grades of imperfection of these bodies as adaptive structures for dispersal. Moreover, within the group they have arisen independently, perhaps several times. In Reboulia, for instance (Haupt, 1921), an elater is homologous with a single spore mother-cell, while in Marchantia and various other forms it corresponds with a row of them.

The sporogonium of Sphærocarpus, one of the most primitive Liverworts, has no dehiscence mechanism. The spore mother-cells are interspersed with cells containing chlorophyll and starch. The latter, however, break down and are used as food material for the developing spores. There are no elaters even of a primitive kind. When elaters are present in other Liverworts, they may be formed from cells such as these scattered among the spores, or they may be combined into elaterophores of various types. In such a form

as Frullania they are attached in four groups to the apices of the four valves into which the capsule splits when mature, while in Pellia the alternate rows of cells forming elaters and spore mother-cells radiate from the base of the capsule, and in Aneura from the apex. The sporogenous tissue

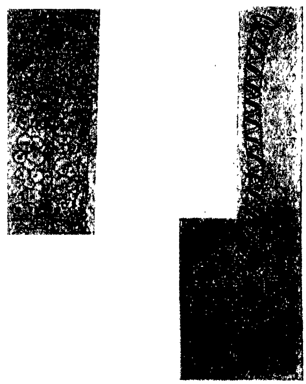

Fig. 7.

becomes differentiated at an early stage into two meristems, which later form respectively the spore mother-cells and elaters. In Frullania the alternate rows of spore mother-cells and somewhat trumpet-shaped elaters are vertical (fig. 7), whereas in the Anthocerotales they are horizontal (fig. 8), indicating that the elaters in these two groups of Liverworts have evolved quite independently.

Again, in Riccia all the sporogenous tissue goes to the formation of spores,

Fig. 8.

but in the related Marchantiaceæ elaters are commonly arranged diffusely in the sporangium. It has been shown, however (Cribbs, 1918) that in Marchantia the elaters are sometimes so abundantly developed in the centre of the capsule as to produce a sort of columella. This is doubtless a germinal variation, and suggests how the closely similar condition of the elaterophore

in Pellia has arisen. Thus we have again parallel lines of variation in two quite distinct groups of Liverworts.

As regards the elaters themselves, they may be very primitive, with smooth walls and but slightly elongated, as in some species of Anthoceros (fig. 9); and a variety of intermediate conditions occur, up to the beautiful elaters of forms like Reboulia, Pallavicinia or Fimbriaria, which elongate greatly in development and have single or double spiral thickenings (fig. 10). As already mentioned, these are laid down inside the cell. The granular portion of the cytoplasm arranges itself in a spiral band, from which is deposited the spiral thickening which gives the elater its peculiar character, most of the protoplasm being used up in the process.

In the Anthocerotales the conditions are so interesting that I should

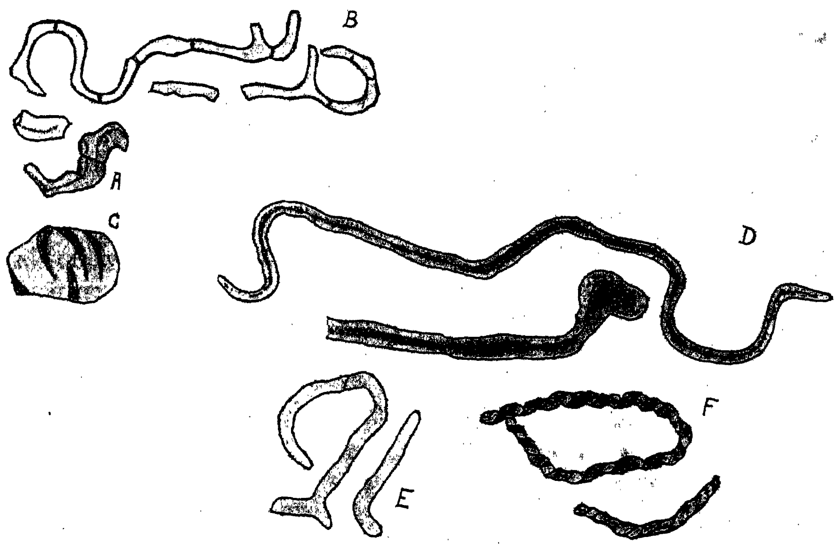

FIG. 9.

like to refer to them a little further. As is well known, the sporophyte in Anthoceros is greatly elongated and consists of a central column of sterile cells surrounded by sporogenous cells in short horizontal rows, the whole enclosed by wall layers. Lang (1907) has shown somewhat similar conditions in Notothylas. In the sporogenous tissue more or less regular alternate rows of cells form respectively spore mother-cells and elaters. Miss Bartlett (1928) has made a comparative study of various species. She finds that in *Anthoceros Hallii* the elaters are very primitive, showing only slight elongation, in *A. hawaiiensis* they are more elongated and attached end to end, while in *A. vesiculosus* they are much more elongated and with few cross walls. In *Notothylas Breutelii*, on the other hand, they are short and broad, but with primitive spiral markings, and in *Dendroceros Clintoni* they show an elaborate spiral (see fig. 9). Here we see adaptation marching

forward on at least two separate fronts—elongation and spiral thickening of the elaters. Yet species with elaters in all these conditions survive at the present time. Faced with such a situation, one must have qualms of doubt as to whether natural selection of chance mutations is a complete explanation.

May we glance for a moment at the elaters of another form, Equisetum. Here Nature has taken a different line, for she has attached two pairs of beautiful spoon-shaped elaters with long handles and expanded tips to each spore (fig. 11). These structures are formed as an outer wall to the spore, and according to Beer (1909) they are deposited by the surrounding tapetum. They are extremely hygroscopic, opening out as they dry and curling together again with a breath of moisture. In so doing they hook round each other, and this is an advantage, for as half the spores produce a male gametophyte and half a female, it is desirable that they should germinate in proximity. These elaters are also believed to aid in the dehiscence of the sporangia (see fig. 12). They seem to have reached perfection for the functions they have to perform. The group is, of course, an old one, going back to the Carboniferous, but when and how the condition of elaters attached to the spores began is unknown.

The sporangia of Equisetum contain several wall layers of cells with spiral markings (fig. 13). Spiral marks are also found in the wall cells of the sporangium of Ginkgo and various Abietineæ, and it has been pointed out by Jeffrey and Torrey (1916) that these cells are in touch with the spirally thickened elements of the xylem and transfusion tissue at the base of the sporangium. But it would take us too far to consider here the innumerable dehiscence mechanisms in plants from the standpoint of cellular adaptation.

The spiral, annular and scalariform markings of *xylem tracheids* and vessels are universally known and have been studied from the early days of the microscope. But even now little has been learned in detail of the development of these structures. In a recent paper (Barkley, 1927) it is shown that the cytoplasm of the living cell first arranges itself peripherally in the cell in zones of looser and denser material having respectively larger and smaller vacuoles. The finely vacuolated bands of zones are then transformed into the lignified thickenings of the cell wall. The nucleus has broken down in the meantime, and gradually disappears with the rest of the cytoplasm. We have, however, no knowledge of the forces at work to produce this differentiation of cytoplasmic zones, nor of why the arrangement is spiral in one cell and scalariform in its neighbour.

Another striking cellular adaptation is to be found in the remarkably elongated and *coiled suspensors* of the Cycads and Conifers. In these groups, polyembryony is the universal condition. Several archegonia are fertilised in each ovule, but after a stringent competition only one embryo survives in the mature seed. A long suspensor in the young embryo is an evident advantage in that it pushes the embryo down into the midst of the endosperm,

FIG. 10.

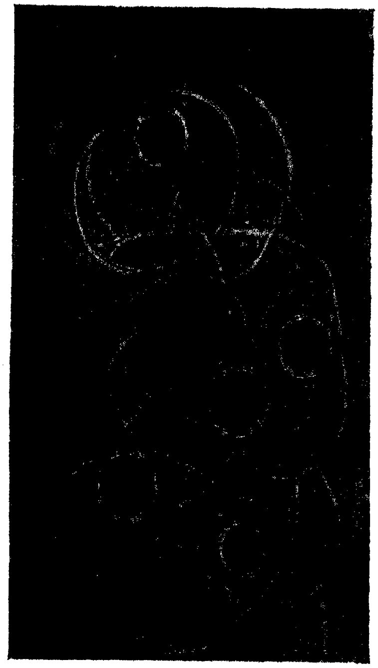

FIG. 11.

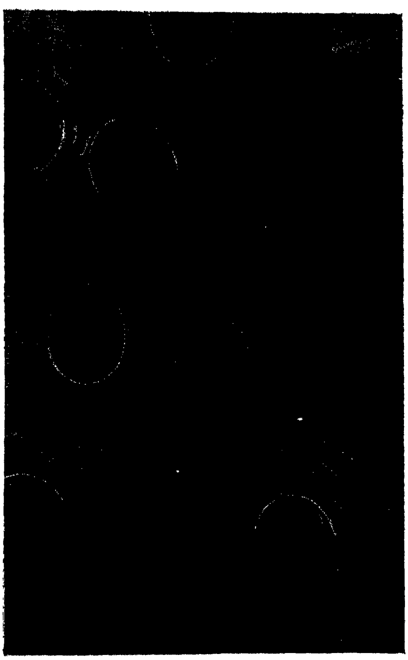

FIG. 12.

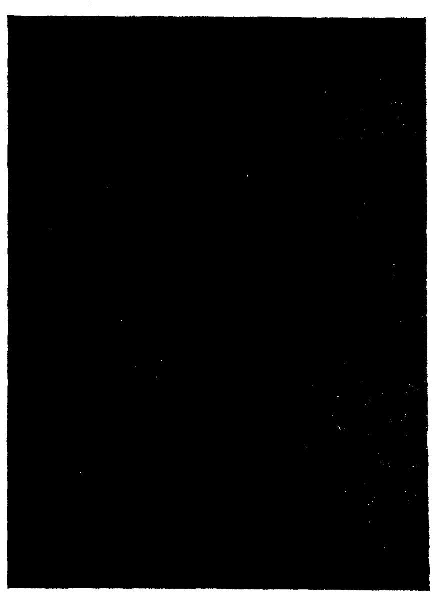

FIG. 13.

Face p. 10.

where there is an abundance of food material for growth. Its length is due to the great elongation of its cells. This condition of simple polyembryony is found in all Cycads and also in certain Conifers, such as Larix and Picea.

Cleavage polyembryony is the well-known condition in Pinus and several other genera of Conifers, as well as Ephedra. Here, in addition to the competition between embryos from different archegonia, each young embryo of Pinus splits into four by separation of the cells. This, of course, intensifies the competition.

There appears to be no escape from the view that in these embryos the tendency for the suspensor cells to elongate has been greatly developed, and, indeed, over-developed, as a direct result of competition and selection between embryos. This has been called (Buchholz, 1918, 1922) developmental selection. It has not been sufficiently emphasised that it is the *cell* character of elongation in one dimension which has thus been vastly exaggerated, if not entirely developed, through a form of natural selection which can be and has been attentively studied. The fact that selection has so obviously been at work in modifying these embryonic stages of development to form the enormously elongated suspensors of Cycad and Conifer embryos is perhaps the best direct evidence available that natural selection acts in a similar way on independent organisms in their struggle for food. The differences in detail between the embryos of different Gymnosperms show that advantage has been taken of such germinal variations as appeared, and these were not always the same. But we are left in the dark as to the cause of these variations or mutations. Even at the present time there seems no better word than Darwin's term "spontaneous," although recent work suggests that radiations of short wave-length may be concerned.

Many more instances of adaptive cell structures might be advanced, but this is not necessary for our purpose, which is to show that the problems and principles in the study of cell adaptations are similar in all essentials to those of adaptations in the organism as a whole or in particular organs. It appears that whatever other evolutionary factors may be advanced, the selection of favourable germinal variations through the vast periods of geological time still constitutes the most fundamental principle of explanation we have. In comparing the many adaptations for the same function, such as the elaters we have been examining, we see very different degrees of perfection and different routes towards the same goal. It is obvious that selection can only act upon such variations as appear, and that different kinds of variation have been characteristic of different lines of descent. It seems that at times evolutionary progress towards a particular adaptation must have been suspended for long periods owing to the failure of the necessary variations to appear.

With increasing knowledge of mutations, it has become clear that germinal variations do not merely follow the laws of chance, but each appears in a particular species or strain with a frequency which is characteristic of

itself. Parallel mutations, the same variation in different lines of descent, have been much emphasised in recent years, since I first introduced the conception (Gates, 1912), and an enormous number are now known, particularly in plants (see also Gates, 1921, and Vavilov, 1922). In the complementary situation we have one series of variations characteristic of a certain line of descent, and another series characteristic of a related phylogenetic line. Why certain variations should repeatedly occur in one line of descent and not in another nearly related line is one of those mysteries of which we have no explanation at the present time.

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EXPLANATION OF FIGURES.

All the figures, except figs. 7, 8 and 9, are from photomicrographs made by my laboratory assistant, Mr. C. S. Semmens, from preparations and specimens in the Department of Botany at King's College. Fig. 4 is from a preparation made by Dr. E. J. Schwartz.

Fig. 1.—*Stemonitis fusca.* ×6.
Fig. 2.—Portion of capillitium of same under high power. ×100.
Fig. 3.—*Cribraria argillacea*, showing character of the capillitium. ×100.
Fig. 4.—Plasmodium of Lycogala, showing an elater. ×300.
Fig. 5.—Elaters and spore of *Trichia persimilis.* ×300.
Fig. 6.—Smooth capillitium and spores of *Geaster fimbriatus.* ×100.
Fig. 7.—*Frullania dilatata*, showing—(a) elaters alternating with vertical rows of spore mother-cells; (b) a single trumpet-shaped elater (after Cavers).
Fig. 8.—Portion of Anthoceros sporogonium, showing alternating horizontal rows of spore mother-cells and elaters (after Bartlett).
Fig. 9.—Elaters of Anthocerotales—(a) *Anthoceros Hallii*; (b) *A. hawaiiensis*; (c) *Notothylas Breutelii*; (d) *Anthoceros vesiculosis*; (e) same from another locality; (f) *Dendroceros Clintoni* (after Bartlett).
Fig. 10.—Spores and elaters of *Pellia epiphylla.* ×300.
Fig. 11.—Shed spores of Equisetum showing attached elaters. ×300.
Fig. 12.—Equisetum spores with coiled elaters (in the sporangium). ×400.
Fig. 13.—Sporangium wall and spores of Equisetum. ×100.

612.111.6. II.—MICROSCOPICAL STUDIES IN PERNICIOUS ANÆMIA. II.

By W. E. Cooke, M.D., F.R.C.P., F.R.M.S., and
C. F. Hill, M.Inst.M.M., A.Inst.P., F.R.M.S.

(*Read February* 18, 1931.)

Six Plates.

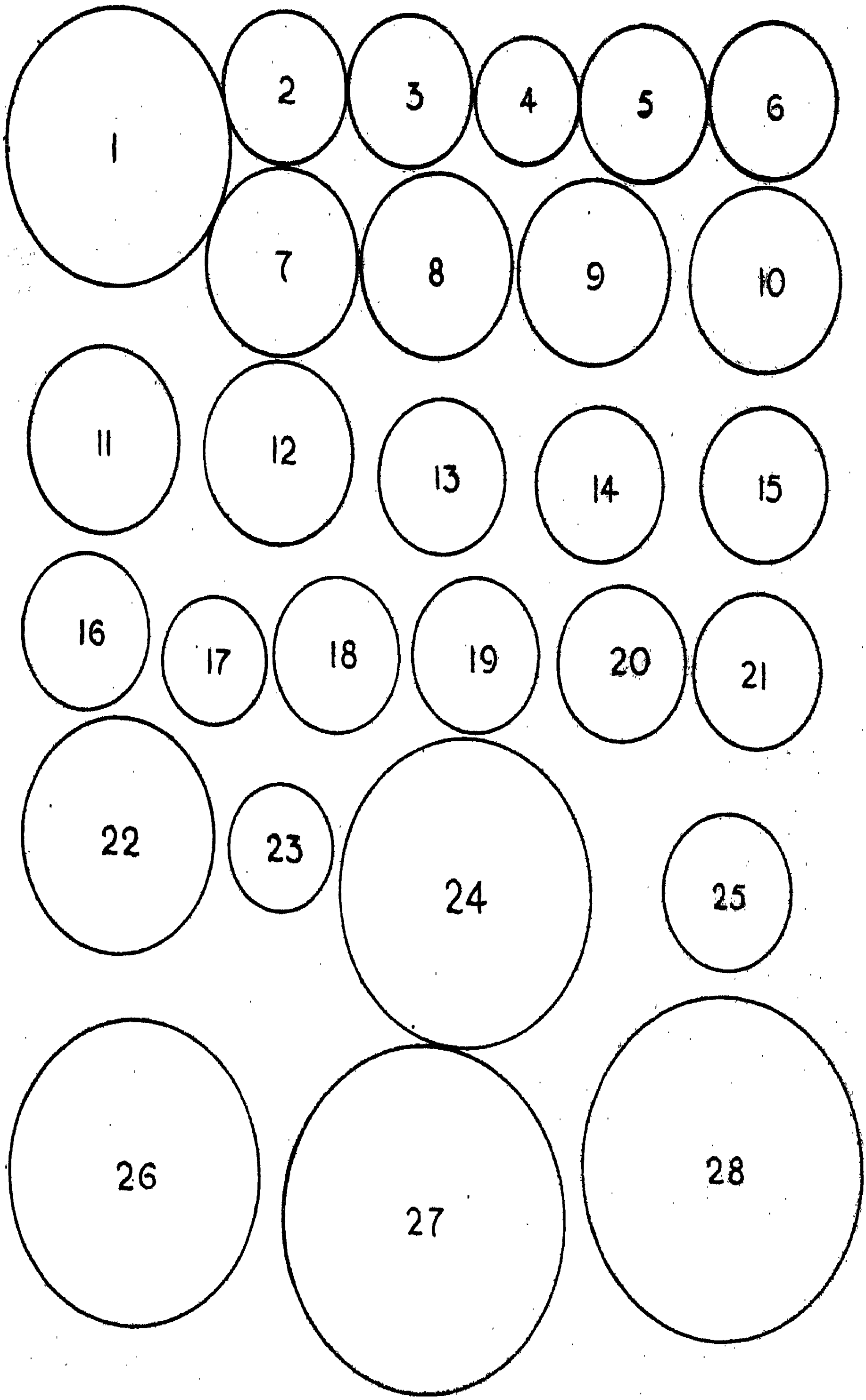
The Hæmoglobiniferous Cells (*continued*).

The Basophilic Conditions found in Erythrocytes.

Ehrlich (1885) described polychromasia, in which certain erythrocytes stain a bluish colour with azur-eosin stains in contrast to the normal yellow reddish colour or orthochromasia, punctate basophilia or stippling when the red cell contains blue or blue-black granules, and reticulation in which, by vital staining, a bluish network is demonstrated within the cell. The presence of any of the conditions is a sign of immaturity of the red corpuscle. Diffuse polychromasia and reticulation are seen in normal blood. Punctate basophilia and the condition which we shall describe as granular polychromasia are always pathological.

All observers agree with Hawes (1909), Key (1921, 1924), Brookfield (1928), Davidson and Gulland (1930), that the staining substance is the same in, and that a close numerical relationship exists between, the three conditions. The subject has been reviewed by one of us (W. E. C., 1928, 1929, 1930), and the work which was the basis of these papers confirmed the view that the stainable substance is the same in each case, and that it is not chromatinic in character. The nature of this substance and why reticulation necessitates vital staining for its demonstration are the problems before us. That the substance is not nuclear is conclusively proved by its staining reaction with azur-eosin preparations, and by the fact that it is not seen in fresh preparations by dark-ground illumination nor by mercury vapour light. We believe the stainable substance is the remnant of the original cytoplasm of the erythroblast. Wright, quoted by Key, evidently had this theory in mind, and Professors G. Lovell Gulland and Stanley Davidson have frequently expressed the same view to us. This theory is supported by microscopical evidence.

We will consider polychromasia and punctate basophilia together because the one condition merges into the other. Polychromasia may be diffuse or granular. In the diffuse form the colour varies from a faint bluish tinge superimposed on the hæmoglobin stain to a deep blue. In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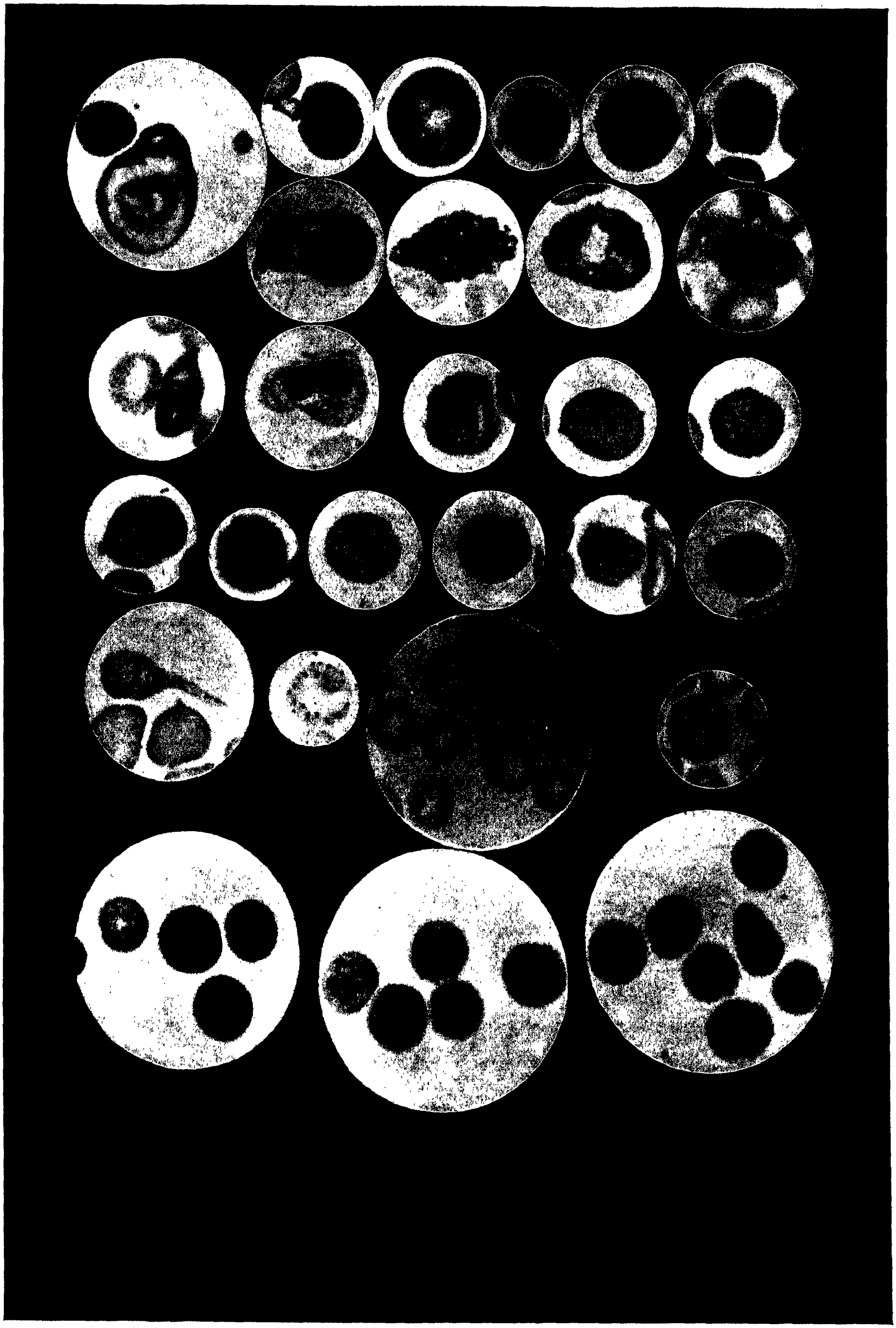


plate III, fig. 1, the left-hand cell illustrates the diffuse form. In the minor grades of polychromasia the cell has the biconcave disc shape of a normal erythrocyte. The achromatic centre is present as in the cytes in fig. 5, plate IV, and fig. 1, plate V, and the stainable substance is diffused throughout the homogeneous cell contents. In the more pronounced form the achromatic centre is not present, owing to the even distribution of the cytoplasm in the cell. The cell stains uniformly a deep blue colour. Diffuse polychromasia is the normal condition of the cytoplasm of erythroblasts of the second generation. The cytoplasm of the megaloblast in fig. 8, plate V, contains a considerable amount of hæmoglobin, but had a faint blue tinge.

The granular form of polychromasia is illustrated by figs. 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 in plate III, and the enlargements in plates IV and V. In normal erythrogenesis erythroblasts in films fixed and stained by the usual methods of clinical hæmatology have a homogeneous cytoplasm exemplified by the megaloblast in plate IV, fig. 3. In the second generation erythroblast certain processes take place side by side. The nucleus undergoes endolysis, hæmoglobin is anabolised, and at the same time lipin condensation occurs at the surface to replace the original cell membrane. The original cytoplasm of the erythroblast is involved in this chemical transformation, and all traces of the nucleus and of the original basophilic cytoplasm have vanished before the red corpuscle leaves the marrow. In pernicious anæmia cells fixed and stained in the same manner frequently present a foamy appearance of the cytoplasm, plate IV, figs. 1, 4 and 5, the nodal points of which meshwork are more intensely basophilic than the remainder. The nucleus disappears, and the cytoplasm becoming more condensed, the granular appearance is exaggerated as in the illustrations. Some hæmoglobin may be formed in these cells, as indicated by the pale areas in fig. 3, plate III, and in figs. 4, 5 and 6, plate V. The cells have not the biconcave disc shape of the normal erythrocyte, and there is no achromatic centre. Probably, too, lipin condensation does not take place, because some of these granular polychromasic cells are readily distorted in the process of spreading and show a definite cell membrane. These irregular forms are shown in figs. 7, 8, 9, 10, 11 and 22 in plate III, figs. 6, 8, 10 and 11, plate IV, and figs. 1 and 3, plate V.

The granular form of polychromasia gradually merges into punctate basophilia, and it is often impossible to place a given cell in one or other category. This difficulty will be appreciated by examination of figs. 2 to 25, plate III.

In punctate basophilia the cells are stippled with granules which vary in size from very fine to large and coarse, and granules of irregular shape. The condition may be present in cells with apparently intact nuclei. Plate III, figs. 12 to 25, except fig. 18, are examples of punctate basophilia.

Punctate basophilia would appear to be a later stage of granular polychromasia. Development proceeds, hæmoglobin continues to be elaborated,

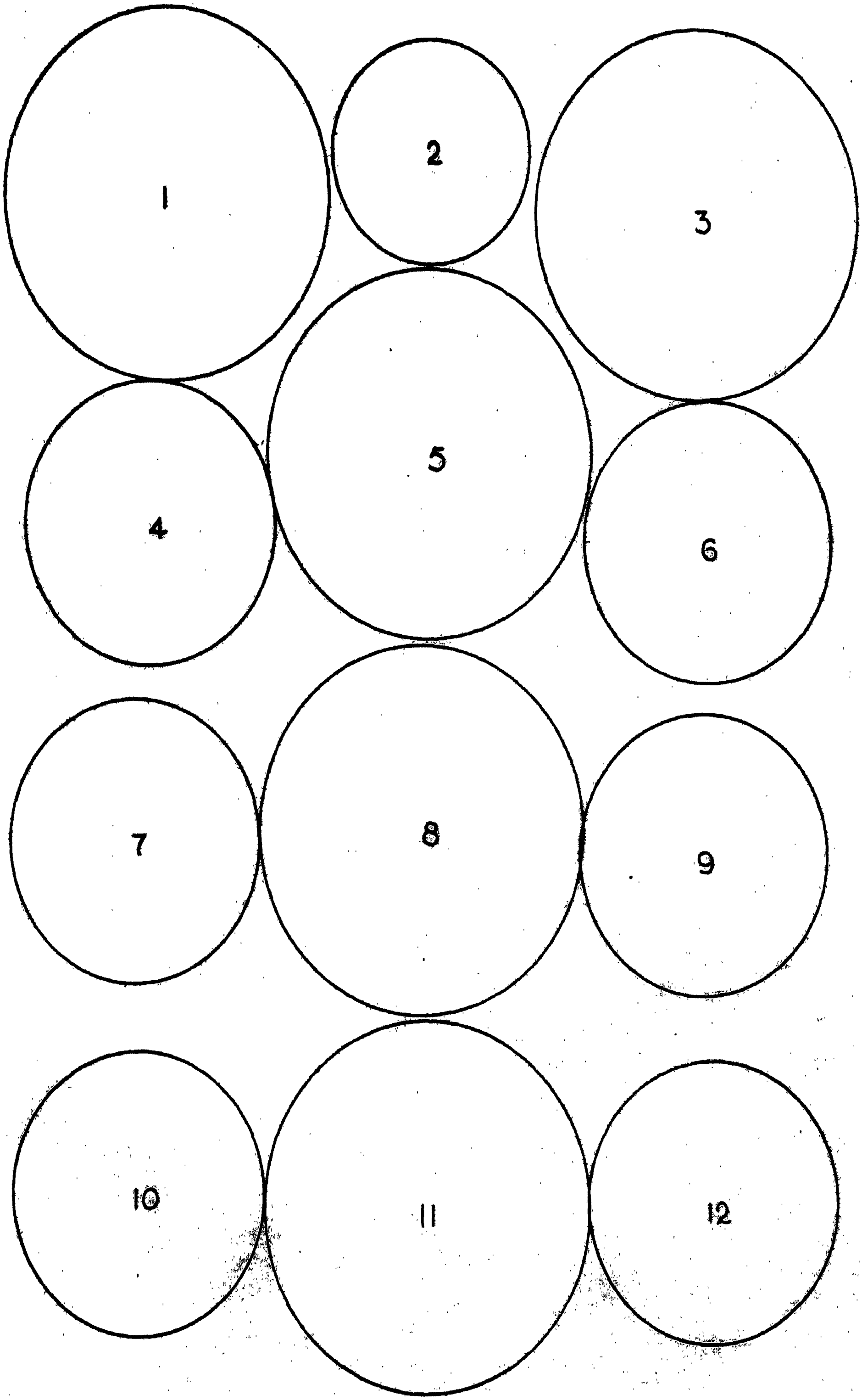
and the lipin covering and cell contents so far approximate the normal that the cell may attain the usual shape as in figs. 23, 24, and 25, plate III. By dark-ground illumination no differences can be detected between these cells and other cells in the film. Part of the original cytoplasm persists, however, and, under the influence of toxic agents, undergoes globulation. Figs. 23, 24 and 25, plate III, are cells from cases of lead poisoning. The cells show very marked achromatic centres owing to the hæmoglobin deficiency which always accompanies the disease.

An interesting feature is that stippling is seen only where there is underlying hæmoglobin. In plate III, figs. 13, 14, 15, 16, 17, 19, 20 and 21, the hæmoglobin is not confined to the periphery, but is evenly distributed through the cytoplasm. Here punctate basophilia is also general in its distribution. In figs. 23, 24 and 25, plate III, stippling is seen to be limited to the areas in which hæmoglobin is present. This can be confirmed by examination of the stained films under dark-ground illumination.

The third basophilic substance—reticulation—demonstrated only by vital staining, is seen in a variety of forms (plate III, figs. 26, 27 and 28), from the complete mossy wreath, the open fragmented reticulum, the reticulum aggregated into the form of a bar, to isolated dots indistinguishable from punctate basophilia. The percentage of reticulocytes in normal blood varies from 0·3 to 0·7. The number of reticulocytes is of primary importance in determining the reaction of the marrow to therapeutic agents such as liver and hog's stomach. An increase in their numbers indicates new formation of red cells, and in pernicious anæmia the percentage often rises from 0·01 to 20 or 30 p.c. in a few days after the commencement of treatment by these substances. In hæmolytic jaundice, where intense destruction of red cells is accompanied by very active regeneration, the percentage of reticulocytes may reach 84 p.c. of the total erythrocytes. Figs. 26, 27 and 28, plate III, were taken from a case of Prof. Gulland's showing this percentage.

We may suppose the structure of a normal red corpuscle to be a biconcave disc without a cell membrane, but having on its surface an aggregation of lipins, according to Görter and Grendel (1925) two molecules in thickness, enclosing a protein stroma with which hæmoglobin is in loose combination. The cause of the shape is the internal stresses peculiar to this particular combination of lipin and colloidal protein.

In pernicious anæmia we have microscopical evidence of chemical defects in the shape of many of the red cells, the fragmentation of the endoplasm, and the persistence of the granular cytoplasm after the nucleus has disappeared. Normally, the original cytoplasm is altered, perhaps it takes some part in hæmoglobin formation, and eventually cannot be demonstrated. The polychromasic and the punctate basophilic cell and the reticulocyte are immature, and it is a reasonable conclusion that the basophilic substance in the three conditions is the remains of the original cytoplasm of the erythroblast. Polychromasia and punctate basophilia stain with azur-eosin stains after fixation in alcohol because their lipin covering is also immature and allows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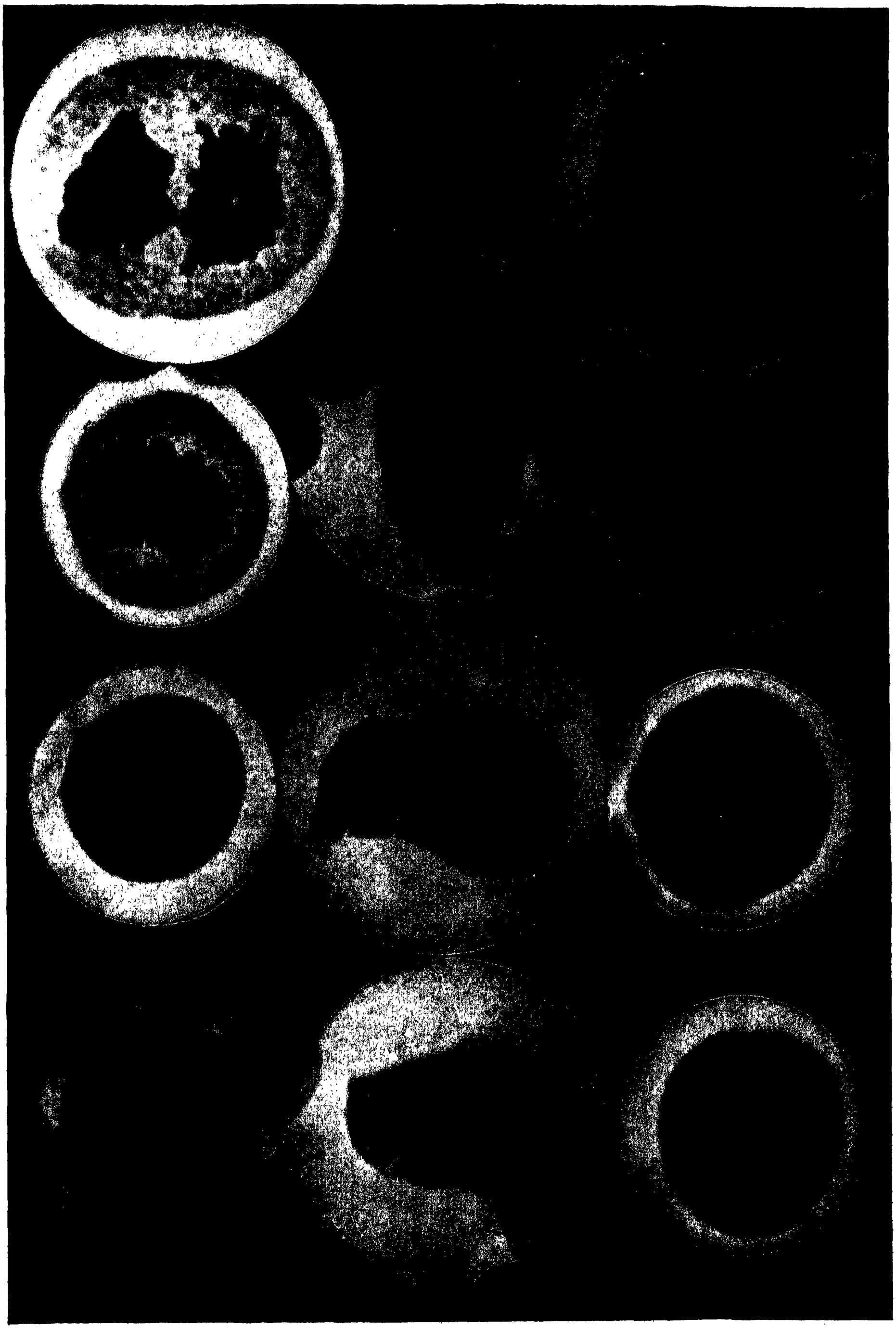

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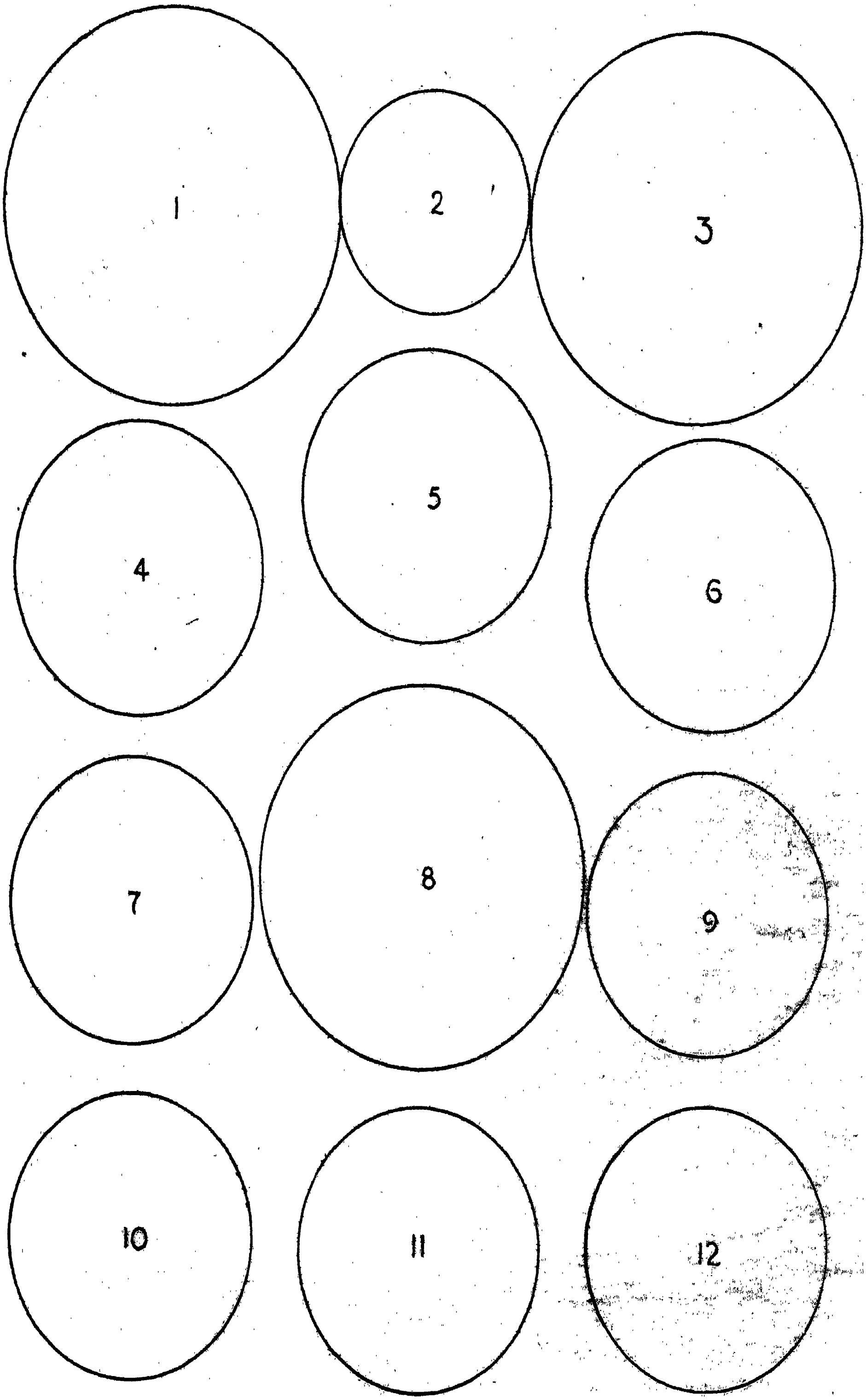
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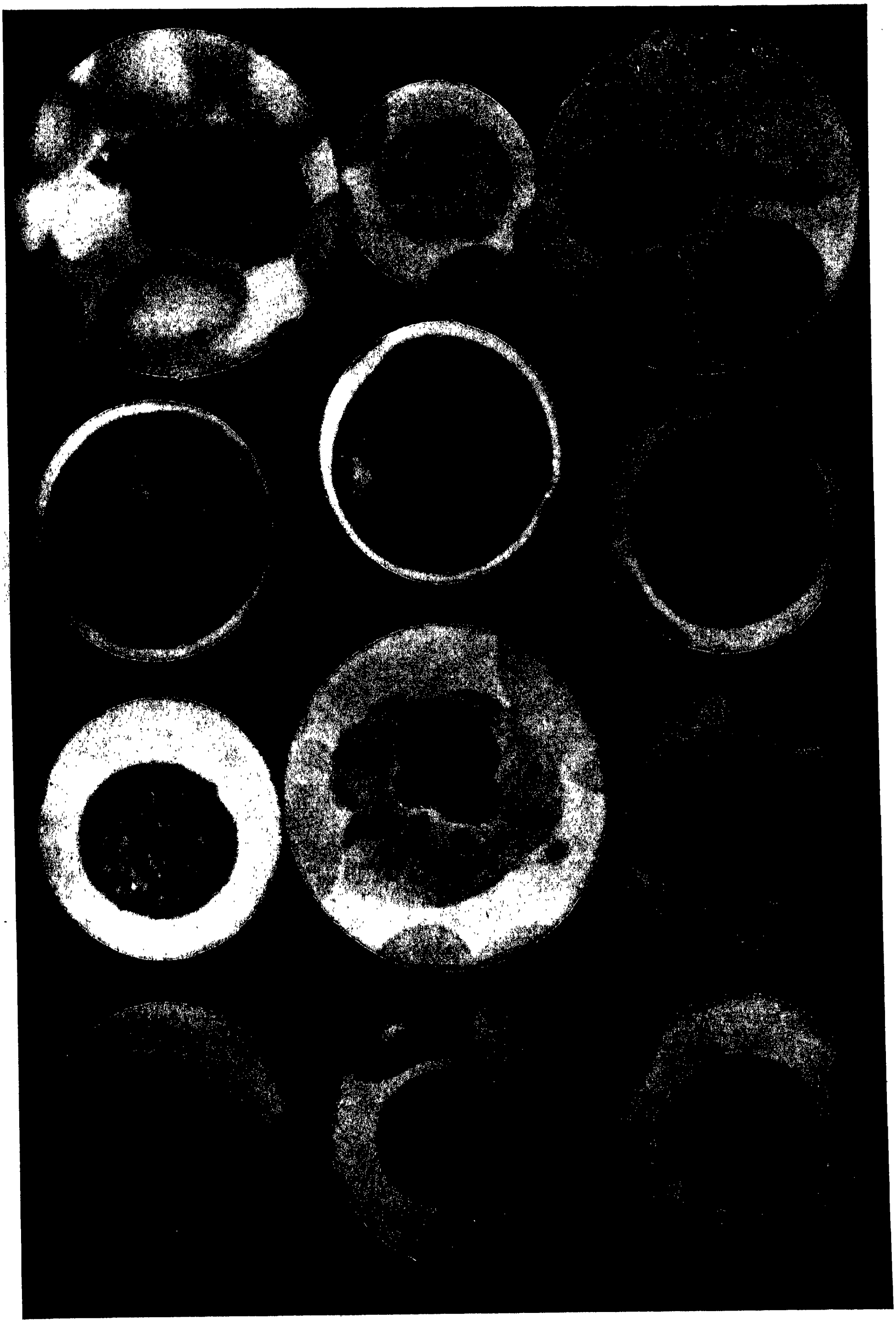

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the dye to penetrate even after fixation. Vital staining brings into evidence reticulocytes, some of which are the polychromasic and the punctate basophilic cells, because although the surface lipins of the cells are impenetrable when the cell is fixed with alcohol, they are pervious to aqueous solutions or when oxidized as by brilliant cresyl blue.

Artificial Simulation of the Basophilic Substances.

Remarkable resemblances to the basophilic conditions can be artificially produced in any red corpuscle. The substance seen in the artificial is not the same staining substance as that shown by the usual methods, and we mention these experimental results merely as an interesting microscopical study.

The unsaturated fatty acids of the lipin covering of the red cell can be oxidized or saturated and rendered soluble by such agents as hydrogen peroxide, and the underlying hæmoglobin demonstrated by the blue meriquinonoid compound resulting from the action of benzidine and hydrogen peroxide. Alcohol added to the mixture fixes the protein of the stroma at the same time. If alcohol, water, benzidine and hydrogen peroxide are flooded on to unfixed blood films, various effects are produced in the red cells depending upon the proportions of the reagents. The result of increasing the amount of hydrogen peroxide is the complete solution of the lipins and the discharge of the whole of the hæmoglobin. This is seen in plate VI, figs. 14, 15 and 16. Plate VII is an enlargement of fig. 16. The protein of the stroma has been fixed, and appears as a spongy meshwork, and the hæmoglobin has been discharged. In figs. 14 and 15 the process has been gradual, and the protein is evenly distributed throughout the cells. In fig. 16, plate VI, and plate VII, the reaction has been immediate. The cells have been fixed in their original shape, and the centres are seen to be devoid of protein. In the upper cell the hæmoglobin is seen leaving the cell *en masse*. By varying the amounts of the reagents, all forms of punctate basophilia and reticulation can be imitated, as shown in plate VI. We have not been able to reproduce diffuse polychromasia completely. The nearest approach is seen in two cells in fig. 13, plate VI, of which plate VIII is an enlargement. There is a rim of unstained material surrounding the blue centre of the cells.

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DESCRIPTION OF PLATES.

PLATE III.

Fig. 1.—On the left is a red corpuscle showing diffuse polychromasia. The other cells in the field are a large misshapen megalocyte and a minute microcyte.
Fig. 2.—Illustrates a diffuse polychromasic megalocyte, and on the left is a schizocyte.
Fig. 3.—The cell is a megalocyte showing diffuse polychromasia and two nuclear rests or Howell-Jolly bodies. Hæmoglobin formation is shown by the lighter areas. Fig. 6, plate V, is an enlargement.
Figs. 4, 5 and 6.—These are examples of granular polychromasia. In fig. 6 a minute nuclear rest is seen.
Figs. 7, 8, 9, 10 and 11.—These cells illustrate granular polychromasia of varying degree in chemically defective megalocytes which have been distorted in the preparation of the film. Nuclear rests are seen in figs. 8, 9, and 10. Enlargements of 7 and 9 are figs. 8 and 6, plate IV, and of fig. 10, plate V, fig. 1.
Figs. 12, 20 and 22.—These are examples of the difficulty in classifying certain cells as either granular polychromasia or punctate basophilia. The cytoplasm of the erythroblasts in fig. 12 contains hæmoglobin; that in fig. 20 is deeply polychromasic. The cell in fig. 22 contains a nuclear rest and is enlarged in fig. 3, plate V.
Figs. 13, 14, 15, 16, 17, 19 and 21.—These cells from cases of pernicious anæmia illustrate the various forms of punctate basophilia. Enlargements of figs. 14, 15, 16 and 21 are seen in plate V, figs. 10, 12, 9 and 11.
Fig. 18.—This cell illustrates a difficulty that occasionally arises. The granules are nuclear rests and not stippling. They stain a reddish purple with azur-eosin stains, and are visible in fresh preparations by dark-ground illumination. An enlargement is seen in fig. 7, plate V.
Figs. 23, 24 and 25.—These erythrocytes show punctate basophilia in lead poisoning, and illustrate the finding that stippling occurs only in the parts of the cell which contain hæmoglobin.
Figs. 26, 27 and 28.—The cells in the figures are reticulocytes, and illustrate the various forms of reticulation. The blood films from which these photomicrographs were taken, were from a case of acholuric jaundice under the care of Prof. G. Lovell Gulland.

× 1,000 diameters.

PLATE IV.

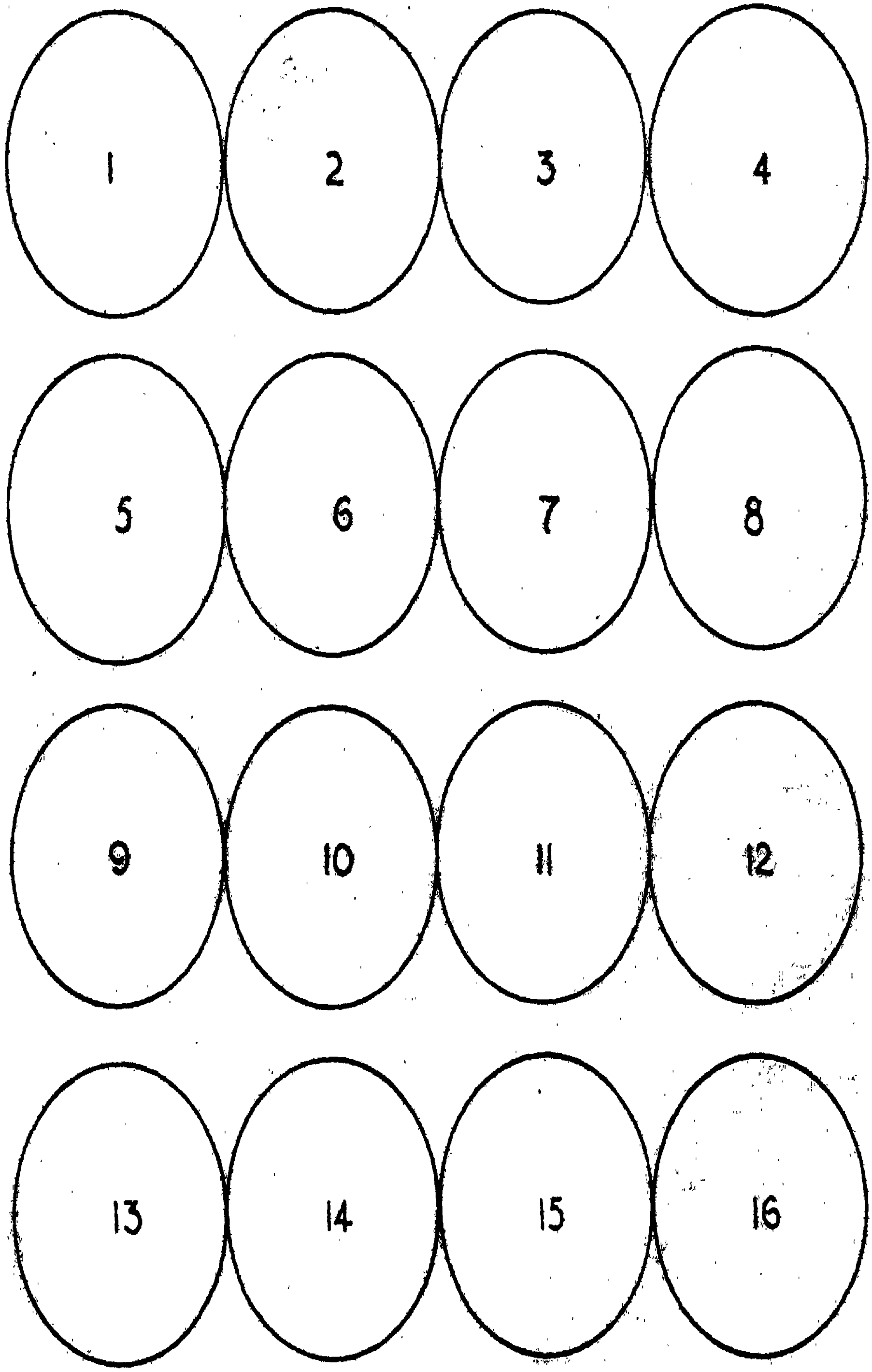
Figs. 1, 4 and 5.—The cells are megaloblasts, and illustrate the foamy basophilic cytoplasm in contrast to the homogeneous cytoplasm of the cell in fig. 3. The nucleus of the megaloblasts in fig. 5 is undergoing degeneration.
Fig. 3.—Illustrates the homogeneous basophilic cytoplasm of a megaloblast.
Figs. 2, 6, 7, 8, 9, 10, 11 and 12.—These megalocytes illustrate granular polychromasia in varying degrees. Howell-Jolly bodies are seen in figs. 2 and 6, the irregular chromatin granule type of nuclear rest and an incomplete Cabot's ring in fig. 9, an incomplete Cabot's ring in fig. 10, and a complete Cabot's figure of 8 in fig. 12.

× 2,000 diameters.

PLATE V.

Fig. 1.—A misshapen megalocyte showing granular polychromasia and a nuclear rest.
Fig. 2.—Nuclear rests in a very faintly polychromasic megalocyte.
Fig. 3.—This cell illustrates the difficulty in deciding between granular polychromasia and punctate basophilia. A nuclear rest is present.
Figs. 4, 5 and 6.—The cells are megalocytes of varying degrees of polychromasia in which hæmoglobin has commenced to be elaborated. Figs. 4 and 5 illustrate the irregular granule form of nuclear rests, and in fig. 6 are two small Howell-Jolly bodies.
Fig. 7.—This is an enlargement of fig. 18, plate III. The granules are chromatin and due to karyorrhexis and are not stippling.
Fig. 8.—Illustrates a megaloblast with a pycnotic nucleus undergoing karyorrhexis. The cytoplasm is homogeneous and faintly polychromasic.
Figs. 9, 10, 11 and 12 are examples of punctate basophilia.

× 2,000 diameters.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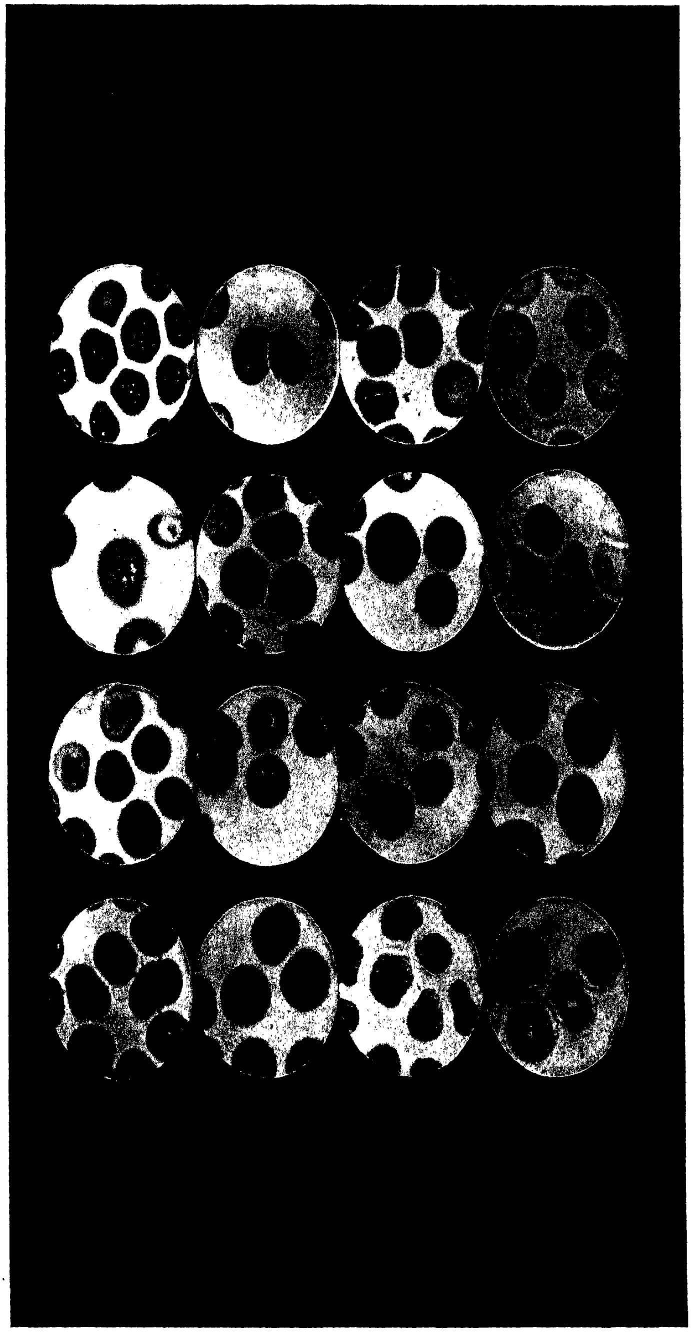

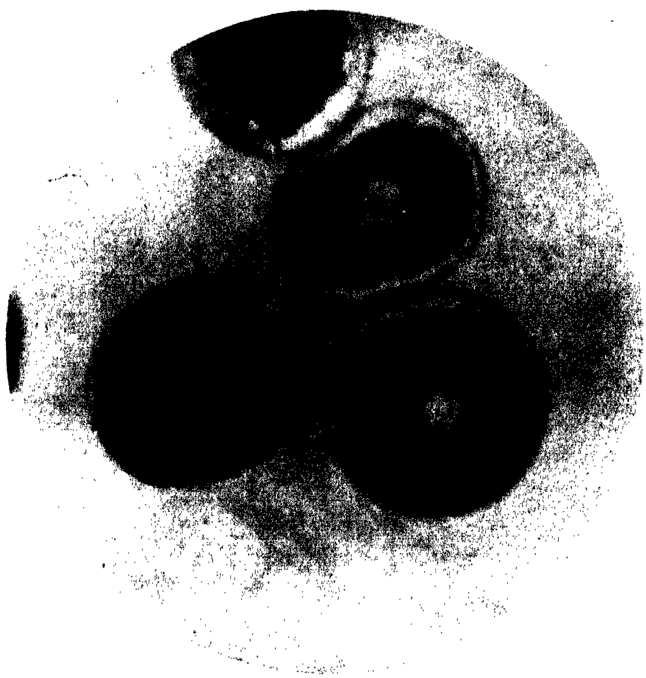

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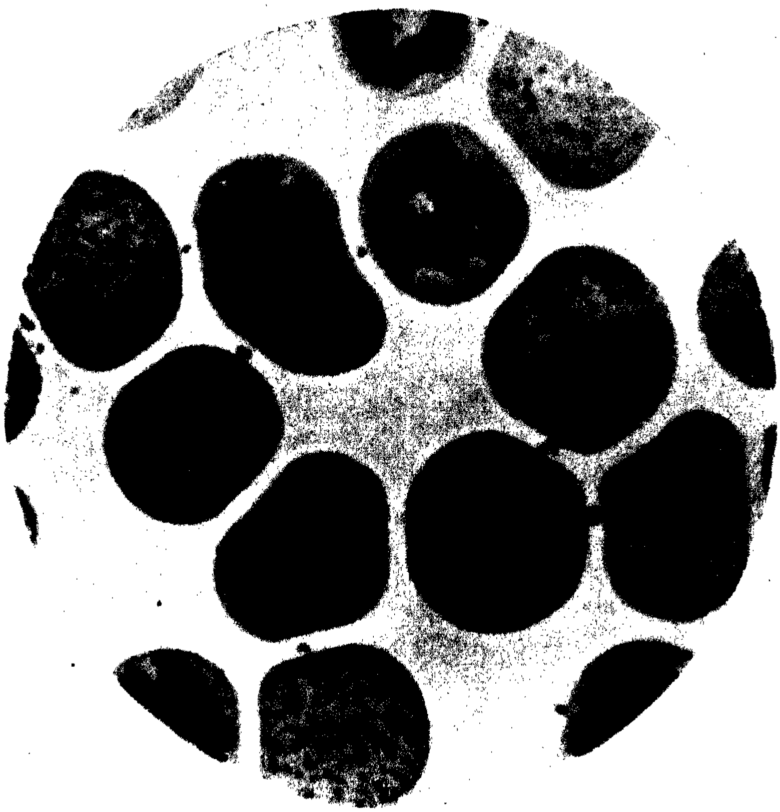

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Face p. 18.

PLATE VI.

Artificial Simulation of the Basophilic Substances.

Fig. 1.—Illustrates the suggestion of pores obtained by the action of hydrogen peroxide and weak alcohol on erythrocytes.

Figs. 2, 3, 4, 5, 6, 7 and 8.—Illustrate various forms of punctate basophilia obtained by the method described in the text.

Figs. 7, 8, 9, 10, 11 and 12.—Illustrate various forms of reticulation obtained by the same method.

Fig. 13.—Illustrates two polychromasic erythrocytes obtained as above.

Figs. 14 and 15.—Illustrate the spongy stroma of the erythrocyte. Fig. 15 shows the hæmoglobin in the process of being discharged.

Fig. 16.—Illustrates the spongy stroma of the erythrocyte. In one erythrocyte the hæmoglobin is seen leaving the corpuscle *en masse*.

× 1,000 diameters.

PLATE VII.

This is an enlargement of fig. 16 in plate VI. × 3,500 diameters.

PLATE VIII.

This is an enlargement of fig. 13 in plate VI. × 3,000 diameters.

535. 8. 28.

III.—A UNIVERSAL TUBE-LENGTH AND COVER-GLASS CORRECTING LENS SYSTEM FOR USE WITH MICROSCOPE OBJECT-GLASSES.

By R. J. Bracey, F.Inst.P., of the British Scientific Instrument Research Association, 26, Russell Square, W.C. 1.

(*Read November* 19, 1930.)

About two years ago, in a conversation with me, Sir Herbert Jackson mentioned an idea which he had had in mind for many years, namely, the need for an instrument which could function as a correction collar and yet be mounted independently of the lens with which it was used, and that if such a lens system were produced, it would make it possible for various object-glasses to be used with different thicknesses of cover-glasses and at different tube-lengths from those for which the object-glasses were originally corrected. In effect, the microscopist equipped with such a system would have the equivalent of a correction collar adjustment for all his object-glasses.

A consideration of the potentialities of such a lens system showed that it would have advantages, apart from cost, over and above those which could be secured by having all object-glasses fitted with correction collars.

The ordinary high-power, large numerical aperture, oil immersion lens must always be used at the tube-length for which it is corrected by its maker. The effect of variation of thickness of cover-glass and the depth of the object in the mounting medium is usually small when the whole system is nearly homogeneous. An independent correcting lens system would enable the tube-length to be varied, and this is sometimes desirable for reasons which will be given later.

It is well known that, when dry lenses are being used, particular attention must be paid to the thickness of cover-glass mounted over the specimen, and, if the specimen is not mounted dry, to the depth of the specimen in the mounting medium. These quantities become more and more important with increasing power and numerical aperture in the object-glass. If the object-glass is not supplied with a correction collar, adjustment for these quantities is made by varying the length of the draw-tube.

The variation of the draw-tube to compensate for small errors is open to certain criticisms.

If it is required to measure the dimensions of an object, it is convenient that the magnification of the object-glass shall be some round figure such

as 40 or 60 and not 37·4 or 59·2; it seldom happens that the correct length of draw-tube for the given cover-glass corresponds to a magnification which can be expressed in round figures.

When a number of photomicrographs are being taken from different slides, it is very undesirable, when correcting the object-glass, to be constantly changing the length of the draw-tube and, in consequence, the camera position.

A very serious objection with high-power dry lenses is the fact that the change of tube-length is sometimes insufficient to cover all the variations that may be met with in the mounting of the object.

When working with many binocular microscopes, the draw-tube length used must be such as to cause the eyepoint separation to agree with the interpupillary distance of the observer, and unless a correction collar is supplied with the object-glass, the cover-glass thickness must be correct when working with high powers.

There are certain inherent disadvantages in the use of correction collar lenses: an important one, for example, is that there is always one position of the collar at which a lens is best corrected for zonal spherical aberration and chromatic aberration. Since it would be a counsel of perfection and impracticable to say that a lens must always be used with the correct thickness of cover-glass, some means of correction must be provided, and the correction collar affords the most convenient and practicable means hitherto devised.

The correction collars employed for this purpose achieve their object by moving the component lenses along the axis, and, unless the components are separately achromatised, this procedure is likely to introduce small amounts of chromatic aberrations as well as the amount of spherical aberration needed to neutralize the effect of the cover-glass.

By the use of a separate lens system which could function as a correction collar, these disadvantages could be avoided. In the first place its components could be made achromatic in themselves, so that no change of colour correction would occur. Secondly, in addition to being a correcting system for variation in cover-glass thickness, by its very nature it would also be a correcting system for any variations in tube-lengths or in magnification which might be desired. Thirdly, if such a separate lens system could be made applicable to the highest-powered object-glasses, it would be available for use with any lower powers as well, since these would require the introduction of less corrective spherical aberration than the higher powers. Fourthly, such a separate correcting lens system would require no changes to be made in the standard microscope object-glass mountings, and could be manufactured as a separate universally applicable article of microscope equipment; in other words, there would be no occasion for the existence of the separate series of object-glasses described as correction collar object-glasses. Fifthly, such a system would prove invaluable with a binocular microscope.

A description of the way in which such a correction lens system has been designed may be of interest. It is well known that an object-glass, if used on a different pair of conjugate points from those for which it is corrected, will introduce a certain amount of spherical aberration into the image-forming pencils, and that this error can be used to compensate the spherical aberration due to an incorrect thickness of cover-glass. It is also well known, and justified by many experimental tests, that when this correction is made *within reasonable limits*, there is no deterioration in the defining power of the objective. For reasons which will be at once apparent, when it is remembered that the object-glass itself is fully corrected for colour, the disturbance of the chromatic balance is also zero, when this method of correction is used, provided again that it is made only within reasonable limits.

In this connection it may be pointed out that a large change in draw-tube length of a high-power lens only means a very small change in the distance of the object from the first principal point of the lens.

If we take the reciprocals of the conjugate distances, we can easily see that the changes introduced are of an order which is small although not infinitesimal.

It is not surprising, therefore, that the normal method of correcting an object-glass by varying the length of draw-tube leads to results which are optically satisfactory.

All microscope object-glasses are corrected for the sine condition, in addition to being spherically and chromatically correct. It follows from this that small changes in the reciprocals of the conjugate image and object distances are related in very similar ways for all classes of microscope object-glasses.

These facts make the designing of a correcting lens system possible, and show that what is requisite for this purpose is a lens system behind the object-glass which shall be capable of varying the convergence of the pencils of light emerging from the object-glass.

In other words, what is necessary is a variable power achromatic or apochromatic lens system which is fully corrected in itself, for coma, spherical aberration, and zonal spherical aberration. Such a lens system is, of course, a mathematical impossibility, yet it can be so closely approximated to, that in practice such an approximation is found to be of a high order of utility.

It is, of course, a well-known fact that a large portion of optical designing work consists in making compromises which finally result in systems of undoubted merit, but this is only in accordance with the tolerances which the nature of light and vision permit.

An investigation carried out on the preceding lines resulted in the production of a variable power system composed of an achromatic positive triplet followed by an achromatic negative doublet with a variable separation between these two components.

The variable separation gives the appropriate range of power to the

whole system, while the errors arising from change of separation are so arranged as partly to neutralize those due to changes of thickness of cover-glass and tend to reduce the displacement of the object-glass from its normal working position. This arrangement of residual errors slightly increases the working range of the system, which is a very definite advantage.

This lens has all the potentialities indicated earlier, which is, perhaps, a sufficient justification for describing it as a " Universal Corrector." The system has been manufactured by Messrs. W. Watson & Sons, and is being exhibited to-night by them.

Actual tests of the Universal Corrector have shown that it has a very large working range, and produces no perceptible change in the performance of the object-glasses with which it is used, except, of course, to bring them into full correction. It has one effect, however, when used in conjunction with an object-glass : it increases the total magnification slightly.

In conclusion I should like to say how much the realization of the design of the Universal Corrector owes to the encouragement and enthusiasm of Sir Herbert Jackson, which very materially lightened the arduous labour involved in the optical design.

535.42. IV.—EXPERIMENTAL STUDIES IN DIFFRACTION.

By Fredk. W. Shurlock.

(*Communicated October* 15, 1930.)

Two Plates.

Foreword.

The Council has accepted for publication, in the present volume of the Society's Journal, the series of papers by the late Mr. F. W. Shurlock on experimental studies in diffraction, of which the following is the first.

These papers contain many points of interest to microscopists and others to whom a knowledge of microscopic optics is of importance, and, while in some particulars the views expressed may not agree entirely with some more recent theories on the nature of light, nevertheless, so great has been the care with which the experiments have been prepared and described, and so comprehensive is the series of photographs illustrating the experiments, that their publication will, it is hoped, serve a useful purpose.

After careful consideration it has been thought desirable to publish the text in entirety, without alteration or amendment, since it will be understood that the views and interpretations expressed are those of the late author.—Ed.

Introductory.

It is generally recognized that, in demonstrating the fundamental facts of diffraction, it is best to dispense, as far as possible, with optical complications, such as collimators and telescopes, and to employ simply a brilliant source of light, the diffractory object and a white screen.

In the experiments here described this course has been consistently followed, except that the screen is replaced by a photographic plate. From the negatives a complete set of lantern slides has been made. This course has a number of advantages. A permanent record of each experiment is obtained; the slides are available for illustrating lectures; they show detail which it is difficult to observe on a screen or in prints which must be examined by the aid of a lens; further, they can be measured, and in suitable cases furnish, in conjunction with the bench measurements, data for arithmetical exercises in the wave theory. In the discussion of the Abbe

experiments it is shown that the method has advantages as a means of investigation.

The papers which follow have some bearing on the theory of the microscope image, and may perhaps be of service as essays towards a satisfactory physical presentation of the theory of image formation suitable for microscopists of moderate mathematical attainments. They are, of course, written from the point of view of the physicist rather than the expert microscopist. Such a presentation, in addition to the simple geometrical theory of image formation, requires a knowledge of the principal phenomena of interference and diffraction.

In the paper "Experiments Illustrating the Wave Theory" the experimental facts corresponding to the principal results of the mathematical theory are presented, experiments 23 to 29 on the action of a slit and 30 to 35 on the action of low-power gratings being included because of their bearing on succeeding papers.

The paper on "The Formation of Images," whilst assuming the simple geometrical theory of image formation, directs attention to the part played by interference in image formation, and suggests that a highly magnified image may legitimately and usefully be regarded as the focused shadow of the opaque parts of the object with the addition of an interference figure. Incidentally, Abbe's experiments with the grating with alternate long and short lines are repeated by manipulating the spectra in the image plane of the source of light.

Abbe's diffraction experiments appear to have attracted little attention from physicists. They have, however, been the source of much controversy among microscopists, in the course of which it has sometimes been suggested that the behaviour of light in the microscope differs in some way from its behaviour in other circumstances. It therefore appeared worth while to investigate these experiments and to endeavour to repeat them on a larger scale, apart from the microscope.

For the paper "Abbe's Diffraction Experiments," the distributions of spectra in the neighbourhood of the back focal plane of the objective were photographed. Microphotographs of the original experiments were taken, first of all, with the objective for which the Abbe apparatus was designed, and, secondly, with an objective of higher power; an adjustable slit was made to fit the apparatus, so that the changes in the image of the grating with alternate long and short lines could be continuously observed; finally, the whole of the experiments were repeated apart from the microscope on a larger scale and explained in terms of the form and distribution in the image plane of the images of small areas in the source.

The designs used in the paper "Diffraction from Geometrical Patterns," with the exception of the octagonal star, are confined to those which it is thought may be of service to microscopists. In highly magnified images it is important to know the extent to which the appearances correspond with actual structure and how far they are modified by diffraction. Cell structure

is often roughly hexagonal or circular, and it seems likely that a study of the diffraction figures from simple hexagon and circle patterns may throw light on the question. The equilateral triangle pattern is an obvious modification of the hexagon design, and the second hexagon pattern is included because it has been quoted in discussions of the Abbe experiments (*cf.* fig. 63, p. 69, "The Microscope and its Revelations," Carpenter-Dallinger, 7th edition, 1891).

Experiments Illustrating the Wave Theory.

A continuous current arc was employed as the source of light in these experiments. The interference pattern was obtained on a screen, which was then replaced by a photographic plate.

(1) Two pinholes. (Interference bands.)

Diameter of pinhole source, 0·34 mm. Diameter of pinholes, 0·28 mm. Distance between centres, 1·2 mm. Source to pinhole, 104 cms. Pinhole to screen, 111 cms.

By measuring the distance between the bands (0·046 cms.) a mean value for the wave-length may be calculated.

(2) Two pinholes. (External bands.)

In (1) the interference effect is not confined to the geometrical projection of the pinholes.

The internal and external effect require different exposures. No. (2) is an enlarged photograph of (1), showing bands external to the geometrical projection.

(3) Two slits. (Interference bands.)

This is an enlarged image of the bands from two slits, obtained by the aid of a lens of 12 cms. focal length, a single slit being employed as source. The lens gives an enlarged image of the interference pattern in the plane conjugate to the screen.

Width of slits, 0·1 mm. (about). Distance apart, 1·4 mm. Source to slits, 106 cms. Slits to lens, 53 cms. Slits to screen, 123 cms.

(4) Fresnel's mirrors. (Interference bands.)

The pattern was projected by a 12 cm. lens, as in (3).

Slit source to intersection of mirrors, 26 cms. Mirror to lens, 75 cms. Lens to screen, 75 cms.

(5) Bi-prism. (Interference and diffraction bands.)

The pattern was projected by a 12 cm. lens, as in (3).

Slit source to bi-prism 60 cms. Bi-prism to screen 240 cms. Bi-prism to lens, 70 cms.

(6) Wide slit. (Diffraction bands.)

Slit source to slit of 6·4 mm. width, 60 cms. Wide slit to source, 243 cms.

One edge of the slit was bevelled and one rounded. The photograph shows the softened edge and two diffraction bands in each case.

(7) Wide slit. (Monochromatic light.)

Yellow-green light from an arc spectrum was allowed to pass through the narrow adjustable slit which was employed as the light source.

Slit source to slit of 6·4 mm. width, 60 cms. Wide slit to screen, 200 cms.

Diffraction bands completely fill the geometrical projection of the wide slit.

(8) Row of pinholes. (Pinhole source.)

Source to pinholes, 25 cms. Pinholes to screen, 50 cms. Separation of pinholes, 1·7 mm.

Each pinhole image is accompanied by two diffraction rings and the ring systems of adjacent pinholes are separate.

(9) Row of pinholes. (Pinhole source.)

Source to pinholes, 100 cms. Pinholes to screen, 60 cms. Separation of pinholes, 0·97 mm.

In this case the ring systems of adjacent pinholes images overlap.

(10) Single pinhole. (Slit source.)

Slit to pinhole, 36 cms. Pinhole to screen, 48 cms.

We may imagine the slit to be divided into small elements which are contiguous. These give rise to pinhole images, which are also contiguous or may slightly overlap and these form the pinhole image of the slit. The diffraction rings of (8) and (9) are now replaced by two diffraction bands, one on each side of the image of the slit.

(11) Narrow slit. (Pinhole source.)

Pinhole to slit, 25 cms. Slit to screen, 50 cms.

A pinhole source was used to illuminate a narrow adjustable slit. A single diffraction band is seen on each side of the projection of the slit.

(12) Narrow slit. (Slit source.)

Light source to diffracting slit, 25 cms. Diffracting slit to screen, 50 cms.

Two diffraction bands may be distinguished on each side and the brightness of the first order bands is greatly increased.

(13) Narrow slit. (Slit source.)

Source to diffracting slit, 109 cms.
Diffracting slit to screen, 106 cms.
The photograph shows external bands.

(14) V-slit. (Slit source.)

Source to V-slit, 50 cms.
V-slit to screen, 50 cms.
Angle of V, 17′ (about).

(15) Stout wire.

Diameter of wire, 0·13 cms. Slit source to wire, 60 cms. Wire to screen, 243 cms. Separation of internal bands, 0·8 mm.

The photograph shows internal interference and external diffraction bands.

(16) Point of fine needle. (Yellow-green light.)

Slit source to needle, 60 cms. Needle to screen, 200 cms.

(17) Circular aperture. (Yellow-green light.)

This set of photographs was taken with a Swift No. 3 eyepiece, 3·4 cms. in length.

Diameter of pinhole source, 0·34 mm. Diameter of aperture, 1·1 mm.

Source to aperture, 60 cms. Eyepiece to screen, 24·3 cms.

The successive distances from the aperture to the eyepiece were :—1·4, 2, 2·4, 2·7, 3·5, 4·3, 5·1, 6·4, 7·8, 11·5, 15·8, and 28 cms. respectively.

(18) Larger circular aperture.

Diameter of pinhole source, 0·34 mm. Diameter of aperture, 3·81 mm.

Source to aperture, 60 cms. Aperture to screen, 115 cms.

With the arc source only two rings are clearly shown.

(19) Larger circular aperture. (Yellow-green light.)

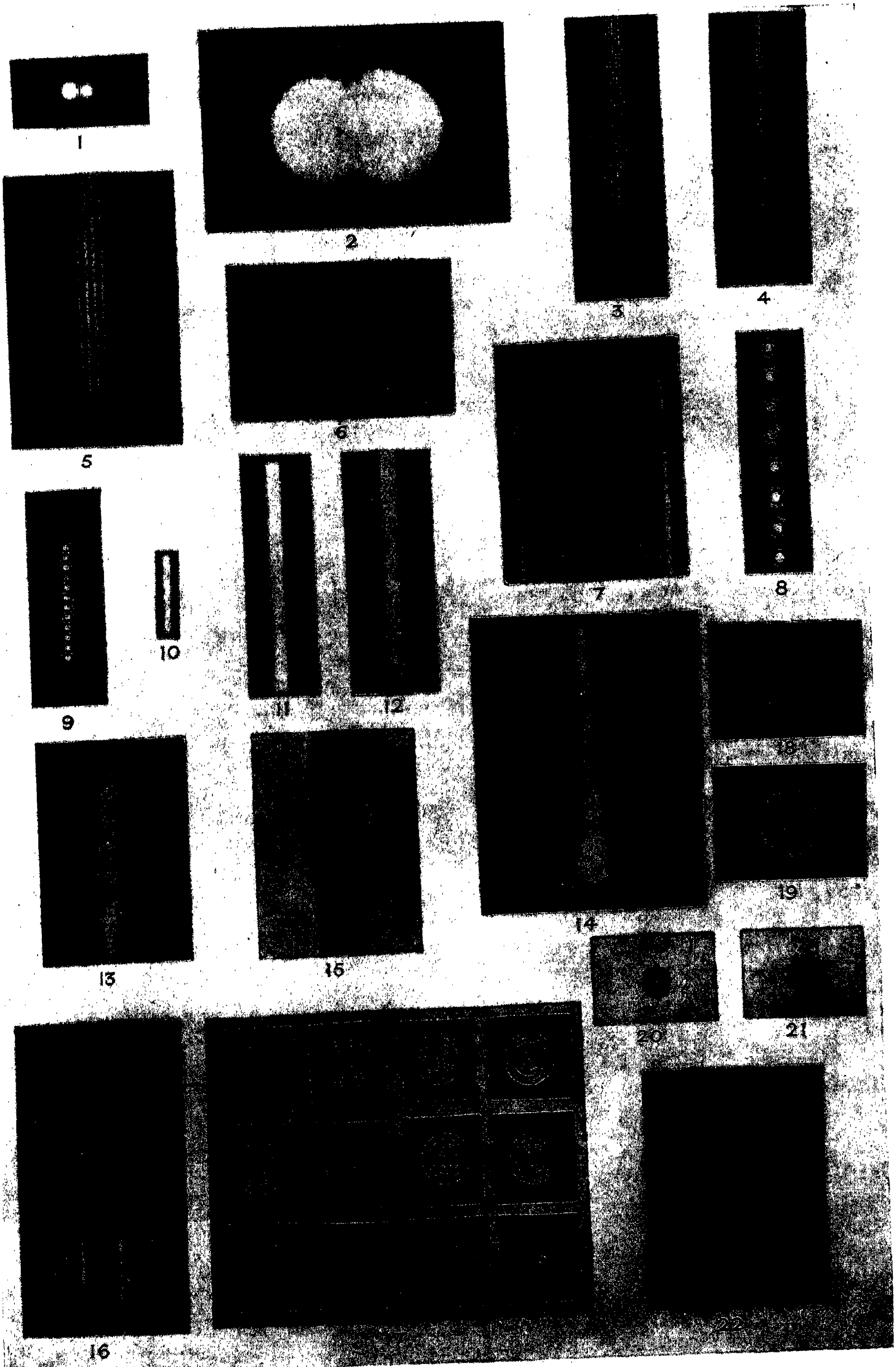
Diameter of pinhole source, 0·34 mm. Diameter of aperture, 3·81 mm. Source to aperture, 60 cms. Aperture to screen, 115 cms.

Employing yellow-green light from the arc spectrum the black centre and seven rings may be distinguished.

(20) Arago spot. (Yellow-green light.)

The base of a small brass cone attached to a microscope slide served as the diffracting object.

Diameter of pinhole source, 0·34 mm. Diameter of base of cone, 1·95 mm. Source to object, 60 cms. Object to screen, 108 cms.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(21) Arago spot with rings. (Yellow-green light.)

Diameter of pinhole, 0·34 mm. Diameter of base of cone, 1·95 mm.

Source to object, 53 cms. Object to screen, 122 cms.

Mean distance between consecutive dark rings, 0·4 mm.

The negative was over-exposed and reduced to show the rings, with the result that the spot is somewhat enlarged.

(22) Zone-plate photograph.

A zone-plate of 180 cms. focal length with 230 zones was used to photograph the carbon filament of a 16 c.p. lamp.

Lamp to zone-plate, 4·3 metres. Zone-plate to screen, 2 metres.

The filament with reflections of the filament in the glass bulb may be distinguished.

(23) Effect of slit on the image of a small circular aperture.

Light from a continuous current arc was condensed on the pinhole of diameter 1·1 mm., and an enlarged image of the pinhole focused on the screen by a Goerz photographic lens of 5·3 ins. focus. A narrow adjustable slit was placed between the lens and the screen.

Pinhole to lens, 18 cms. Slit to screen, 62 cms.

The image of the pinhole consists of a central bright disc surrounded by one dark and one bright ring. The effect of the slit is to throw the light into a band at right angles to the direction of the slit. The figures show successive stages of the process as the slit is closed.

(24) Effect of slit on image of square.

In this experiment a small square aperture of 0·7 mm. size replaced the pinhole of (23), two sides being placed parallel to the direction of the slit. The arrangements were the same as in (23), except that the distance from the slit to the screen was 45 cms. The figures show the effect of closing the slit as before. The final result is indistinguishable in form from that resulting from a circular aperture.

(25) Effect of slit on image of larger square.

A similar experiment was made with a square of 1 mm. size, having two of its sides parallel to the direction of the slit. The arrangements were the same as in (23). As before, the image is spread out into a band at right angles to the direction of the slit.

(26) Effect of slit on image of larger square unsymmetrically placed.

The sides of the 1 mm. square were in this case inclined to the direction of the slit, the arrangement being as in (23). In this case the band which finally results is nearly, but not quite, at right angles to the direction of the slit.

(27) Effect of slit on image of rhombus.

The aperture was in this case a rhombus of 1 mm. size, the arrangements being as in (23). The final result is a band at right angles to the direction of the slit.

(28) Action of slit on image of larger rhombus.

In this case the aperture was a rhombus of 2 mm. size, the axes being inclined to the direction of the slit. The resulting band is nearly, but not quite, at right angles to the direction of the slit.

(29) Diffraction by small rectangular aperture.

Pinhole to lens, 86 cms. Lens to screen, 170 cms.

The image of the pinhole previously employed was focused by a 10 ins. lens on a screen, a small rectangular aperture of length 1·2 mm. and breadth 0·7 mm. being inserted close to the lens, between the lens and the screen. A yellow screen was placed between the arc and the pinhole. The figure shows crossed spectra, but a record of the faint spectra in the quadrants could not be obtained.

(30) Diffraction by grating. (Pinhole source.)

A row of images is obtained at right angles to the direction of the lines of the grating. The pinhole was focused by the Goerz lens and the grating, a piece of process plate with 150 lines to the inch, inserted close to the lens. A yellow screen was employed.

Pinhole to lens, 17 cms. Lens to screen, 67 cms.

(31) Diffraction by gratings crossed at right angles.

The arrangements were as in (30) but two similar gratings with 150 lines per inch crossed at right angles were substituted for the single grating.

Two principal rows of spectra at right angles are obtained with spectra in the quadrants. The eight first order spectra are comparable in brightness with the central image.

(32) Diffraction by gratings crossed at an angle of 60°.

The arrangements were as in (30) except that the gratings were crossed at 60°.

Two principal rows of spectra at right angles to the lines of the grating respectively are obtained with rows of spectra parallel to the principal rows. As in (30) the first order spectra are comparable in brightness with the central image.

(33) Diffraction by crossed gratings.

The arrangements were as in (30) except that a piece of process plate, consisting of two gratings with 200 lines to the inch crossed at right angles, was employed. The brilliant colour is, of course, not reproduced


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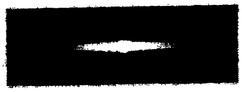
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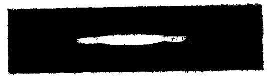
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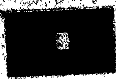
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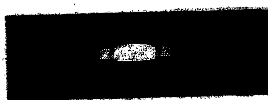
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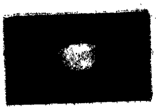
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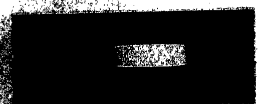
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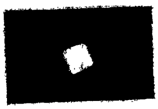
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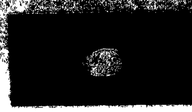
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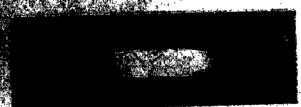
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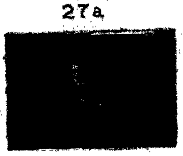
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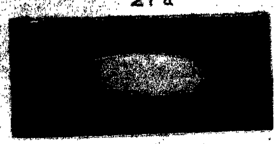
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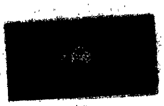
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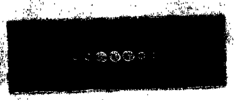
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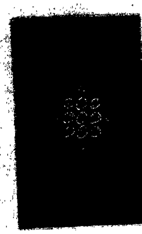
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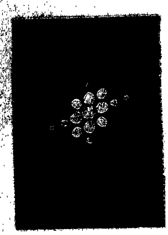
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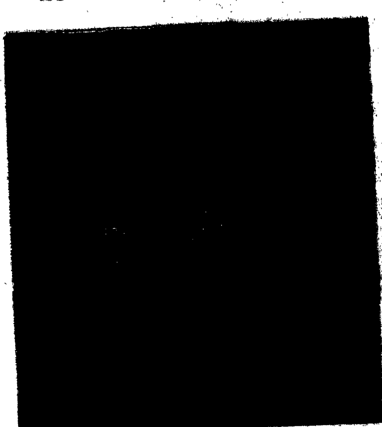
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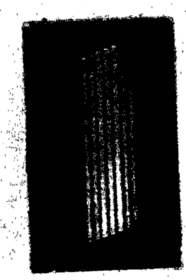
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(34) Diffraction images of slit.

Slit to lens, 20 cms. Lens to screen, 45 cms.

An image of a slit was focused by the Goerz lens on a screen. A grating of 150 lines to the inch was placed close to the lens between the lens and the screen with the lines of the grating parallel to the slit. A yellow screen was employed.

It will be noticed that the first order spectra are comparable in brightness with the central image, also that irregularities in the slit appear as dark lines at right angles to the central image and, therefore, at right angles to the lines of the grating. This indicates that the illumination along a dark line in the spectra is mainly derived from the light which would focus at the point in the central image where it is intersected by the dark line, supposing the grating were removed.

(35) Diffraction images of slit. (Grating rotated.)

The arrangements were as in (34), but the grating was rotated in its own plane so that the lines of the grating were no longer parallel to the slit. The irregularities of the slit show as dark lines parallel to the straight lines through the ends of the images. Both sets of lines are at right angles to the lines of the grating. The distance between adjacent images measured along these lines is the same as in (34), and as a consequence the perpendicular distance between adjacent images is less than in the case where the grating lines are parallel to the slit, all other experimental arrangements remaining the same.

January, 1923.

OBITUARY.

BERNARD BARHAM WOODWARD, F.L.S., F.G.S., F.R.M.S., was the only son of Bernard Bolingbroke Woodward, Librarian to Queen Victoria at Windsor Castle, and his second wife, Emma, daughter of George Barham, Esq., of Withersdale Hall, Suffolk. The other two sons of " B. B.'s " grandfather, himself well known as a geologist and antiquarian of Norwich, were S. P. Woodward, author of the famous "Manual of the Mollusca," and Dr. Henry Woodward, Keeper of Geology in the British Museum. Each of these was the father of sons who became famous in the same science.

Our subject was born at St. John's Wood, August 8, 1853, and educated at Merchant Taylors' and at University College School. His further education was cut short by the early death of his father, and he became a clerk in Messrs. Robartes, Lubbock & Company's bank. In 1873 he was appointed Curator to the Geological Society, and was responsible for the removal of the Society's collections from Somerset House to Burlington House, at the time when the Royal Microscopical Society failed to obtain its promised apartments in that palatial edifice. In September, 1876, he entered the Printed Book Department of the British Museum. Five years later he was transferred to the new Natural History Museum to take charge of the General Library there. He retired July 21, 1920, but continued to assist with the catalogue for two years longer. He was twice married, but leaves no children. He died on October 27, 1930, and was buried at Brookwood.

B. B. Woodward must be known at least by name to all British conchologists and geologists. He presented me, some years ago, with a considerable collection of material for the study of radulæ, and books and manuscripts bearing thereon. He was most generous, as he had been to Guy Pickering many years before, in appreciation of my early efforts, and now that the map of his life is unrolled, we can see how it was that he never had time to devote himself so fully to conchological microscopy as he himself would have desired, and as his early intentions had promised. For in this respect he considered himself morally the legatee of his uncle, S. P. Woodward, who was the first person to foresee what might be the value of microscopical science to the conchology of the future. As might be expected from his ancestry and the occupations of his life, B. B. W. was a past master at the diagnosis of shells, and he was also a voluminous writer. The business habits which he must have learned in his early youth stood him in good stead, for he answered all letters with promptitude and conciseness. If you appealed to him, his reply came next day. Like many great men,

he was a little intolerant of the pretensions of others to be leaders in his own science, and was never afraid to say what he meant, and perhaps, in consequence, he never secured any of the highest honours of his profession; but the scientific world will know how to regard this slight when they refer to his "Synonymy of the British Non-Marine Mollusca," to the presidential addresses in which he dealt with the subject of Darwinism, and to the many valuable papers in which he, with his *fidus Achates*, Mr. A. S. Kennard, has illuminated the whole subject of the Holocene molluscan fauna of this country. Between 1880 and 1920 he contributed numerous abstracts to our Journal.

E. W. B.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(*Under the direction of* G. M. FINDLAY, M.D.)

HISTOLOGICAL TECHNIQUE AND STAINING.

A Rapid Method of Triple Coloration.—M. HUBIN ("Un procédé rapide de triple coloration," *Arch. de Biol.*, 1928, **37**, 23–9). The stain proposed is permanent in solution as well as in sections. Fix for 24 to 48 hours in Holland's solution, using 5 p.c. trichloracetic acid (about 12 drops to 50 c.c. of the fluid) instead of the glacial; transfer to Bouin for 24 hours, then to 95 p.c. alcohol, and embed as usual. Wash sections to remove the picric acid. Stain in Carazzi's acid hæmatein, 10 minutes for embryonic tissues, 20 to 30 minutes for adult tissues. Place in tap water till the sections are blue (about 15 minutes). Differentiate in dilute acetic acid (12 drops glacial to 100 c.cm. water) for 4 to 5 seconds, and gradually bring up to 70 p.c. alcohol. Stain, with shaking for 1 to 3 minutes in the following solution, ripened for from 8 to 10 months :—1 p.c. aqueous eosin A.G. (Grübler), 10 c.cm. ; 1 p.c. aqueous gold orange (Grübler), 20 c.cm. ; 1 p.c. safranin (Merck) in 50 p.c. alcohol, 20 c.cm. ; absolute alcohol 50 c.cm. Differentiate for a few seconds in acid alcohol (95 p.c. alcohol, 100 c.cm. ; HCl 2 to 3 drops). Transfer to absolute alcohol, xylol and Canada balsam. Sections of mouse embryo stain as follows :—blood vessels brilliant yellow, cartilage violet, zones of ossification blue, muscle brownish yellow, nerves pale yellow, and ganglion cells pinkish-brown, nuclei intense blue, pancreas cells violet, islets of Langerhans brown.

G. M. F.

A Rapid Method for Staining Sections of the Spinal Cord and Brain Stem.—H. M. KNOWER (*Science*, 1930, **72**, 172–3). Sections are cut freehand with a sharp, flat, thin razor about 1 mm. thick, or frozen sections 100μ thick. From 95 p.c. alcohol (minimum 5 minutes) transfer to Cole's mordant (50 p.c. 20 c.cm., ferric chloride 1 gm., glacial acetic acid 2 c.cm.) for at least 5 minutes and then to alcohol. After prolonged mordanting, staining is sometimes superfluous, but the following stain is recommended :—To 5 drops of Cole's "stock hæmatoxylin" (absolute alcohol 20 c.cm., sodium bisulphite 0·2 gm., distilled water 5 drops, light-coloured hæmatoxylin crystals 1 gm.) add 10 drops of water and 1 drop of ammonium hydroxide. After 30 seconds add 5 c.cm. of 95 p.c. alcohol. Stain the sections for about 5 minutes and differentiate with 0·4 p.c. HCl. If necessary, remove sediment with cotton or lens paper. Rinse in slightly alkaline 95 p.c. alcohol after securing proper definition. Examine with a hand lens or a low-power 48 mm. objective on a microscope.

G. M. F.

The History of Staining.—S. I. Kornhauser (" The History of Staining. The Development of Cytological Staining," *Stain Technol.*, 1930, **5**, 117–25). In this instalment of the history of staining cytological methods are dealt with, the period 1875–1895 receiving most attention, as it was then that mitosis, maturation, and fertilization were first fully investigated by the researches of Flemming, Strasburger, van Beneden, Oscar and Richard Hertwig, Boveri and others. It is of interest to note that Bolles Lee, in the first edition of the " Microtomists' Vade-Mecum " (1885) was far from enthusiastic as to the use of aniline dyes. G. M. F.

The History of Staining.—H. J. Conn (" The Staining of Blood and Parasitic Protozoa," *Stain Technol.*, 1930, **5**, 127–34). The majority of blood stains now used are compounds of the eosin-methylene blue group. Although Romanovsky (1891) is usually cited as the originator of such stains, it appears that Ehrlich (1879) first employed compounds of acid and basic dyes for staining blood cells, and had a better understanding of the chemistry involved. G. M. F.

Picric Acid as a Destaining Agent.—Hsu-Chuan Tuan (" Picric Acid as a Destaining Agent for Iron Alum Hematoxylin," *Stain Technol.*, 1930, **5**, 135–8). A saturated aqueous solution of picric acid has been employed for the differentiation of plant material stained by Heidenhain's or Delafield's hæmatoxylin in place of iron alum. The method is of especial value for determining the chromosomes, as the picric acid primarily destains the cytoplasm and leaves the chromosomes practically unchanged. It is essential that the final washing should be thorough in order to remove the last traces of picric acid. G. M. F.

The Staining of Nervous Tissue with Silver.—H. A. Davenport (" Block Staining of Nervous Tissue with Silver : Studies of Fixatives, Lipoid Solvents, and Reducing Solutions," *Stain Technol.*, 1931, **5**, 139–47). Experiments were undertaken to determine the mechanism of silver staining by Cajal's method, when applied to the mammalian central nervous system, with special reference to the limits of favourable ammonia concentration in alcohol as a fixative and a comparison of ammoniated alcohol with alcohol-chloroform and alcohol-pyridine mixtures. The material used was the spinal cord of cats. Such material subsequently extracted with various lipoid solvents showed staining of a generally similar character. More intense staining was seen after the alkaline fixatives, while the best penetration was obtained after the most thorough extraction of the lipoids. Experiments with reducing solutions which contained various proportions of pyrogallic acid and formalin indicated that pyrogallic acid is the essential ingredient. Post-mortem autolysis up to 5 hours caused no change in the staining of fibres. G. M. F.

The Origin of the Automatic Microtome.—Sir R. Threlfall (*Biol. Rev.*, 1930, **5**, 357–61, 1 text-fig.). Various incorrect versions of the origin of the automatic microtome having attained publicity from time to time, the originator of this universally used instrument now states the true facts. The first automatic microtome was constructed at Cambridge in 1883. G. M. F.

A Modified Celloidin Paraffin Method of Embedding.—A. Tschernyachinsky (" Eine Vervollkommnung des Paraffin-Zelloidin-Verfahrens," *Ztschr. f. Wis. Mikr.*, 1930, **47** , 200–1). This is an improvement on a previously described celloidin-paraffin method (*Ztschr. f. Wis. Mikr.*, 42 , 443); the introduction of clove oil allowing better cutting. Material is transferred from celloidin to 3 or 4 p.c. celloidin in clove oil (to a 6 to 8 p.c. celloidin solution in ether-alcohol add an

equal quantity of clove oil) for from 2 to 24 hours. Place in chloroform for ½ hour, transfer to chloroform-paraffin in the oven and leave until the material sinks (½ to 1 hour), then into pure paraffin. G. M. F.

Cytological Staining with Auerbach's Methyl Green-Acid Fuchsin Mixture.—J. O. FOLEY ("Studies in Stain Technique. II. Cytological Staining with Auerbach's Methyl Green-Acid Fuchsin Mixture," *Anat. Rec.*, 1930, **45**, 339–44). The success of Auerbach's stain in cytological work depends largely on the fixative used. The following method of mordanting and staining proved satisfactory for testes of *Romalea microptera*, *Passer domesticus* and *Didelphys virginiana*. Gilson's solution, Allen's B. 15, and Flemming's strong fluid in Hance's modification were used as fixatives. Paraffin sections are brought down to water and placed in 1 p.c. potassium permanganate solution, followed by 1 p.c. oxalic acid. Wash in running water for 30 minutes and mordant in 0·5 p.c. osmic acid for 12 to 24 hours if no osmic acid were present in the fixative. Wash in running and distilled water and stain for 24 hours in a mixture of 80 c.cm. of 0·2 p.c. aqueous methyl green (58 p.c. dye content) and 20 c.cm. of 0·1 p.c. aqueous acid fuchsin (65 p.c. dye content). Wipe off excess of stain and blot, but do not dry completely. Transfer to acidulated 95 p.c. alcohol for from 5 to 30 seconds, then to carbol-xylol, xylol and Canada balsam. Condensed chromatic structures stain brilliant green, more loosely arranged chromatin dark blue-green to purple. Plasmosomes, spindle fibres, and the tails of spermatozoa are light pink to brick-red. Fibrous connective tissue and muscle stain dark red. This stain is especially differential for chromatin nucleoli and developing spermatozoa. G. M. F.

A Modification of Pasini's Stain for the Differentiation of Connective Tissue.—L. WALTER ("Neuartige Anwendung des Pasinischen Farbengemisches zur feineren Untersuchung des Bindegewebes," *Ztschr. f. Wis. Mikr.*, 1930, **46**, 457–63). This is a modification of Pasini's stain for the better differentiation of connective tissue. The tissues may be fixed in corrosive-sublimate, formalin, Carnoy's solution, or, best of all, in Heidenhain's "Susa" mixture, and embedded by any desired method or by the celloidin-paraffin method of Apathy (*Ztschr. f. Wis. Mikr.*, 1913, **29**, 449–515). Sections are cut 3μ in thickness; after removing the paraffin with benzol and the celloidin with ether-alcohol, sections are passed through the alcohols to water and are then mordanted for 24 hours in 2·5 p.c. iron alum. They are then transferred to Pasini's solution (Unna's aniline-blue-orcein 10 drops, 2 p.c. eosin B in 50 p.c. alcohol 12 drops, saturated aqueous acid fuchsin 1 drop, neutral glycerine 5 drops); afterwards to 96 p.c. alcohol, in which they are agitated as long as colour clouds are given off (about 1 minute), then to 100 p.c. alcohol for 1 minute. Drain and pass through xylol to balsam. Collagen fibres stain deep blue, cytoplasm carmine-red. Epithelial cells, centrioles, basal bodies and nuclear structure are brilliant red. Secretory bodies vary. The mucus of the goblet cells is azure-blue, while erythrocytes are yellowish-red. The stain keeps well both in solution and in the preparations. G. M. F.

A New Method for the Staining of Microglia in Tissues Previously Fixed in Formalin.—L. MIR ("Méthode nouvelle pour la coloration de la microglie dans les pièces anciennement formoleés," *Compt. rend. Soc. de Biol.*, 1929, 657–8). The tissues are cut into fragments about 0·5 cm. in thickness and are washed in running water for 24 hours; they are then placed for from 30 to 60 days in a mixture of equal parts of 20 p.c. formol and pyridine, after which frozen sections 15μ in thickness are cut and are plunged for 10 minutes in distilled water made alkaline with some drops of ammonia. The sections are placed for

3 days at least in Hortega's mixture (equal parts of ammonia, pyridine and distilled water), then into a solution of 16 p.c. ammonium bromide in the warm for from 25 to 40 minutes; washed for 10 minutes and then for 5 minutes in distilled water, and placed in 25 c.cm. of distilled water to which are added 50 drops of a solution of ammoniacal silver oxide. At the end of 2 minutes the sections are placed in a solution of 3 p.c. formol, controlling the progress of decoloration under the microscope; next the sections are washed with distilled water, treated with a solution of gold chloride 1 in 500, and fixed in 5 p.c. hyposulphite, cleared in 95 p.c. alcohol and creosote, and mounted in balsam. G. M. F.

A Method of Selective Staining for the Secondary Nuclei of the Pancreas.—N. SANNOMIYA ("Über eine elektive Färbung der sogenannten Nebenkerne des Pankreas, nebst einigen Bermerkungen über das Wesen derselben auf Grund dieser spezifischen Färbung," *Folia Anat. Jap.*, 1927, **5**, 201–11). Fix the tissues in 10 p.c. HCl for 24 hours, then transfer to running water for the same period. Embed in celloidin and section. Stain in a 1 p.c. solution of aqueous acid fuchsin for at least 3 minutes; wash in distilled water. Differentiate in a saturated solution of picric acid 3 to 4 minutes; rinse in distilled water. Transfer to a 1 p.c. solution of phosphomolybdic acid 1 to 2 minutes; rinse thoroughly in distilled water. Dehydrate, clear, and mount. G. M. F.

A Practical Flagella and Capsule Stain for Bacteria.—H. D. BAILEY (*Science*, 1930, **72**, 95–6). Prepare a thin smear from a growth of 15 to 24 hours on agar and dry in air without heat. Cover with the following mordant:—5 p.c. tannic acid 3 parts, 10 p.c. ferric chloride 1 part, for 2 minutes. Pour off the mordant and cover with the following freshly-prepared mixture:—7 drops mordant mixed with 1 drop Ziehl-Neelson carbol fuchsin, 1 drop concentrated HCl added and mixed, then 1 drop concentrated formaldehyde. Apply 7 minutes. Wash in running water. Cover with Ziehl-Neelson carbol-fuchsin and steam gently for 30 seconds. Wash in running water. Blot. In staining peritoneal exudate to demonstrate capsules of pneumococci, the following technique is employed:—apply the mordant for 10 seconds; wash in running water; apply cold diluted carbol-fuchsin for 10 seconds; wash in water and blot. G. M. F.

The Preparation of Permanent Slides of a Rhizopod.—C. D. BEERS ("The Preparation of Permanent Slides of the Rhizopod Arcella," *Science*, 1930, **77**, 122). Transfer Arcellæ from the stock culture to slides with a few drops of the fluid. Leave undisturbed in a moist chamber for 30 minutes, during which the organisms will settle to the bottom and attach themselves to the slides by means of pseudopodia. Pour off the surplus fluid so that only a thin film will cover the animals. Drop cold Schaudinn's solution on to the animals and leave for from 2 to 3 minutes. Transfer to 70 p.c. alcohol, made light brown in colour by the addition of tincture of iodine for 30 minutes, 50 p.c. alcohol, 25 p.c. alcohol and water, 1 to 3 minutes in each. Stain with Delafield's hæmatoxylin (1 part stock solution to 3 parts water) 5 to 10 minutes, or with Heidenhain's iron-hæmatoxylin (mordant 1 hour in 4 p.c. iron alum and stain for at least 4 hours in 0·5 p.c. iron-hæmatoxylin), differentiate, clear and mount. This method is said to leave the animals attached to the slides with pseudopodia extended. Nuclei with their conspicuous karyosomes, as well as the shell aperture and pseudopodia, are well revealed, while chromidia, often overlooked by other methods, are excellently demonstrated. The preparations are clear and permanent. G. M. F.

Embryology, Heredity, etc.

An Hereditary Anterior Pituitary Deficiency in the Mouse.—P. E. Smith and E. C. MacDowell (*Anat. Rec.*, 1930, **46**, 249–57). The authors give an account of studies to determine the primary cause of the dwarfism and infantilism which appeared spontaneously in a strain of mice reared at Cold Spring Harbour. It has previously been shown that dwarfism behaves in inheritance as a recessive Mendelian character depending on a single gene. The endocrine disabilities of the dwarfs simulate those of hypophysectomized rats. Daily implants of fresh anterior lobe bring these defective animals to a normal condition; their weight increases (although they never reach normal adult weight), they become sexually mature and matings are fertile, the endocrine organs enlarge and become histologically indistinguishable from those of normal mice, with the exception of the anterior lobe of the pituitary. The anterior pituitary in these dwarfs is small. Histologically the lobe has the appearance of a connective tissue network; no eosinophil cells are present, but the authors cannot state whether basophil cells are present or not. The implants of anterior pituitary had no effect on the histological appearance of the anterior lobe. It is concluded that the deficiency of the anterior lobe is primarily causal to the other observed abnormalities of the dwarfs. M. A.

Thyroid Size in the Sexes.—O. Riddle (*Amer. Journ. Physiol.*, 1929, **90**). Weights were obtained on the thyroids of 1,917 ringdoves and on 602 common pigeons aged 4–36 months. Within this age limit there is little change in body weight, and in many of the 71 races or strains studied there is little or no change in thyroid weight. All possible factors influencing thyroid weight were controlled, but the thyroid weight, nevertheless, is highly variable. Mean values obtained from the union of all (71) comparable races of ringdoves indicate an excess weight (per unit body weight) in the females of 4·5 p.c. or of 1·8 p.c. The mean for 19 races of common pigeons is 7·0 p.c. In general, those races which have the smallest thyroids show the smallest percentage sex difference in thyroid size; in races characterized by larger thyroids the female glands exceed those of the males by a notably higher percentage. "It is suggested that many individuals of these races have thyroid enlargements similar to those of endemic goitre, and that, as in the human, the females are more often thus affected than the males. The current impression that the normal thyroid in the human female is larger than in the male is probably supported mainly by data from races or regions where thyroid size is high in both sexes. A true sex difference in normal thyroid size has not yet been demonstrated in any species. M. A.

Litter Size and Latitude.—C. B. Davenport (*Archiv. f. Rassen- und Gesellschaftsbiologie*, 1930, **24**, 97–9). The proportion of human labour yielding twins is not the same in all countries. Census returns from eighteen countries are analysed, and it is found that the twin rate per hundred ranges from 2·70 in Norway to 0·54 in Ceylon. In general, the high rates are found in northern countries, the low rates in countries lying near the Equator, though there are exceptions. A comparison is made with the size of litters, in the different localities, of five genera of rodents having each a wide geographical range. It is found that the lower the latitude the smaller and more frequent the litter, and the suggestion is made that the same factor that is responsible for large litters in northern latitudes among rodents acts also in the human species—namely, the long winter period. M. A.

Complete Atrophy of Kidney in Pigeons following Section of the Ureter.—O. Riddle (*Proc. Soc. Exper. Biol. & Med.*, 1930, **27**, 1022–4).

Section of one ureter in the pigeon leads to partial or complete atrophy of the kidney of that side. Pressure develops in the occluded duct and kidneys, and insoluble urates disappear later from the contents of the duct. The uninjured kidney undergoes functional hypertrophy. It is suggested that some or many of the cases of absent kidneys observed in various animal species are not true cases of agenesis, but of atrophy following the malformation, occlusion, or malfunction of the ureter attached to the missing organ. A comparison is made with the effects of sectioning the duct from the testis, which never results in atrophy of that organ.
M. A.

The Age Distribution of Mortality in Bird Embryos and its Probable Significance.—O. RIDDLE (*Amer. Journ. Physiol.*, 1930, **94**, 535–47). The age distribution of 2,010 dead embryos from three distinct kinds of doves and pigeons is figured and described. As has been previously found in the fowl, the age distribution shows two distinct periods or peaks of high death rate. These periods of maximum mortality occur at essentially equivalent pre-hatching stages in all four species, despite the variable length of the incubation periods. The death rate of the first period attains a maximum at the third or fourth day, and the maximum of the second period falls in the final two or three days of incubation. Some explanation other than the action of lethal factors and ordinary incubation conditions is necessary to account for these phenomena, which are probably generally characteristic of avian reproduction. It is suggested that the mortality of the first period is due to failures in respiratory adjustment, while the excess mortality immediately preceding hatching is ascribable to an inadequate water-supply at this period. The many devices of the egg to obtain and conserve its water supply are discussed. It is pointed out that the very device (thick shells) which is utilised by eggs to prevent water loss and avoid death in the final period may too greatly affect respiratory exchanges and thus cause death in the early period.
M. A.

Endocrine Regulation of Reproduction.—O. RIDDLE (*Endocrin.*, 1929, **13**, 311–19). In his presidential address to the Association for the Study of Internal Secretions, Dr. Riddle referred to recent work indicating that the essential processes of reproduction in birds and mammals are not under control of the nervous system. He reviewed the evidence accumulated to show that all the organs of internal secretion are identified with reproductive processes, including the pancreas, thymus, and parathyroid. In doves and pigeons the thyroid is largest in winter and autumn, smallest in spring and summer. The gonads show seasonal changes of directly opposite nature. The blood calcium (interpreted as parathyroid activity) shows changes parallel with the testis and ovary, as also do the spleen and liver. The enlargement of the spleen and liver is not due to a generalized splanchnomegaly, since the intestine is smallest during the period of reproduction. A series of blood and endocrine changes have been found to coincide with every ovulation period in the pigeon, including an increase in blood sugar (injection of insulin suppressed 90 p.c. of ovulations) and in blood calcium. The thyroid shows increased secretory activity at ovulation. It is probable that the thymus bears a special relation to the secretion of the egg enveloped in the bird's egg. Only in the case of secretion no relationship to reproduction can be found, but it regulates a process as highly rhythmic as reproduction. It is concluded, in view of the relatively greater share of the nerves in the control of other active organ systems, that the true hormones may be regarded as agents devised primarily for regulating activities and co-ordinations incident to essential and irregular rhythms.
M. A.

Differential Response of Male and Female Ringdoves to Metabolism Measurement at Higher and Lower Temperatures. — O. Riddle, G. Christman, and F. G. Benedict (*Amer. Journ. Physiol.*, 1930, **95**). At 20° C. measurements of the basal metabolism of three racial groups of ringdoves indicate that the male has a higher normal metabolism (3 p.c.) than the female. By a large number of measurements on males and females of 16 races of ringdoves at 20° and 30° C., it is established that the metabolism of the male suffers a greater decrease with increase of external temperature than does that of the female. Between these limits the decrease in basal metabolism of the male is 28·1 p.c., in the female 20·3 p.c. Hence, under extreme depression of the metabolism by a temperature of 30° C., the metabolism of the females is 7·17 p.c. higher than that of the males, and the authors consider that these animals are therefore in an abnormal physiological state. This differential response of the normal metabolism of the sexes to temperature is important, not only in metabolic studies but in growth, vitamin and nutritional research, since in accurate measurements very different results with the two sexes may be obtained merely through keeping the animals at, or temporarily subjecting them to, a high or low environmental temperature. M. A.

Cytology.

Electrical Polarization and the Stainability of Nerves.—K. Sato ("On the Influence of Electric Polarization upon the Stainability of Nerve," *Folia. Anat. Jap.*, 1929, **7**, 33–43). Bethe's method of electric polarization was used to study the stainability of the sciatic nerve of the frog. The stainability is generally weak in the cathodic portion. Reaction of the dye, unequal distribution of fibrillar acid, and the nature of the electrode make no difference. The density of the tissue at both poles is very important from the standpoint of the physical theory of staining. At the deep-staining anodic portion, not only the axis cylinders but also the connective tissue and nuclei are condensed, while at the less staining cathodic portion they are loosened. The difference in density of the tissues at the two poles is caused by some vital phenomenon during electrification, for in narcotized, poisoned, or heated nerve there is no variation in density at the regions of the two poles. The difference of stainability is influenced by the intensity and duration of the electrical current, by the nature of the medium in which the nerve preparation is kept, and by the temperature. During the passage through the tissue of the current K ions travel more rapidly to the cathode than Ca ions, with the result that the ratio K/Ca increases at the cathode and decreases at the anode. This may in part explain the difference of density and stainability of the tissue at the two poles. G. M. F.

Embryo Extracts made Cell-Free by Freezing.—F. Demuth ("Reinkulturen mit zellfreien Extrakt," *Arch. f. exp. Zellforsch.*, 1930, **10**, 126–7). The use of embryo extract for tissue cultures introduces a fallacy, it is suggested, in the investigation of the continued propagation of fibroblasts over 18 years as claimed by Carrel, and such problems as the alleged transformation of fibroblasts into monocytes. Since centrifugation does not render embryo extract cell-free, it is possible that at each subculture new embryonic cells are reintroduced. Embryo extract has therefore been repeatedly frozen and thawed with CO_2 snow. No living cells could be seen when tissue cultures were made from embryo emulsion treated in this way. G. M. F.

Non-Disjunction in Drosophila.—J. C. Mottram ("The Effect of Carbon Dioxide on the Occurrence of Non-Disjunction in Drosophila," *Journ. Exp. Biol.*,

1930, **7**, 370–72). The exposure of female flies before fertilization to carbon dioxide increases the occurrence of non-disjunction and probably of gynandromorphism. Exposure to β radiation from radium, like exposure to γ radiation, greatly increases the occurrence of non-disjunction. G. M. F.

Intracellular Oxidation-Reduction Studies.—R. CHAMBERS, B. COHEN, and H. POLLACK ("Intracellular Oxidation-Reduction Studies. III. Permeability of Echinoderm Ova to Indicators," *Journ. Exp. Biol.*, 1931, **8**, 1–8). Of the simple and substituted indophenols used, all except those containing a sulphonate radical could be detected in living echinoderm ova after immersion in the indicators dissolved in sea water. All the indophenols containing the sulphonate radical and the three indigo sulphonates failed to penetrate. The amphoteric dyes F, N and the basic dyes Q, Q, R, S, and V readily penetrated the ova. G. M. F.

The Nervous System and Lead Poisoning.—J. M. DE VILLAVERDE ((" I. Sur l'avenir des parties constitutives de la fibre nerveuse dans l'intoxication expérimentale par le plomb," *Travaux du Lab. de Rech. biol. de l'Univ. de Madrid*, 1929, **26**, 163–87, 10 text-figs. " II. L'évolution des lésions de l'écorce cérébrale dans l'intoxication expérimentale par le plomb," *Ibid.*, 1929, **26**, 189–213, 11 text-figs.). The changes produced in the central nervous system of rabbits poisoned by lead acetate are very much more extensive than were formerly imagined. They are here exhaustively described. G. M. F.

The Reticulum of the Ciliated Cells of the Labyrinth and its Relation to the Nervous Terminations.—J. F. TELLO ("El réticulo de las células ciliadas del laberinto y su relación con las terminaciones nerviosas," *Bol. de la real Soc. españ. de Hist. nat.*, 1930, **30**, 357–68, 4 text-figs.). For examination of the nerves of the labyrinth the temporal bone was first fixed in 50 p.c. pyridine for 24 hours, after which decalcification was carried out in 5 p.c. nitric acid to which was added chloral hydrate (10 to 20 p.c.). The ciliated cells are found to be surrounded by a reticulum. In the organ of Corti the reticulum is accumulated in the infranuclear portion of the ciliated cells. The development of this reticulum in rat embryos is described at length. G. M. F.

Oogenesis in the House Gecko.—D. R. BHATTACHARYA ("Notes on Cell Organs in the Oogenesis of the House Gecko," *Allahabad Univ. Stud.*, 1929, **6**, 21–7, 2 pls.). The Golgi bodies conform to the methods of origin, growth, and distribution in the egg usually seen in vertebrates. They play no part in vitellogenesis. Mitochondria are only found in the peripheral zone. Vacuoles are present in the medullary zone of well-developed oocytes. G. M. F.

Cytoplasmic Inclusions in Pila globosa.—D. R. BHATTACHARYA and C. B. MATHUR ("The Cytoplasmic Inclusions in the Oogenesis of *Pila globosa* (Swainson)," *Allahabad. Univ. Stud.*, 1929, **6**, 29–40, 2 pls.). Golgi bodies at a very early stage contribute either directly or indirectly to the formation of fatty yolk spheres. Mitochondria give rise to true yolk spheres, as does the cytoplasm. G. M. F.

The Infiltration of Golgi Bodies during Oogenesis.—D. R. BHATTACHARYA, R. S. DAS, and S. K. DUTTA ("On the Infiltration of Golgi Bodies from the Follicular Epithelium to the Egg," *Ztschr. f. Zellforsch. u. mikr. Anat.*, 1929, **8**, 566–77, 7 text-figs.). Further evidence is brought forward in support of the view that the extrusion and infiltration of Golgi bodies from the follicular epithelium to the egg are established phenomena, at least in vertebrates. G. M. F.

Oogenesis in Indian Tortoises.—D. R. Bhattacharya ("The Cytoplasmic Inclusions in the Oogenesis of Certain Indian Tortoises," *Allahabad Univ. Stud.*, 1929, **6**, 1–20, 10 text-figs.). Golgi bodies originate in the usual juxtanuclear position and form a peripheral layer in the later stages of development. Fatty yolk is formed directly and indirectly by Golgi bodies, and is abundant in the peripheral region of the egg. The cortical layer of Golgi bodies beneath the egg membrane is formed mostly of Golgi elements derived from the follicular epithelium by a process of infiltration through the zona radiata. The mitochondria also grow and multiply in the idiosome area, and later on become distributed in three zones in the egg. Nucleolar extrusions take no part in the formation of yolk. The albuminous yolk is formed by direct metamorphosis of mitochondria into a yolk body and by the formation of a vesicle which is encircled by small mitochondria, and under the influence of which yolk matter is elaborated inside the vesicle.

G. M. F.

Alterations in the Thyroid Gland as a Result of Fluoride Intoxication.—H. Cristiani ("Altération de la glande thyroïde dans l'intoxication fluorée," *Compt. rend de la Soc. de Biol.*, 1930, **103**, 554–6). Chronic intoxication with fluorides produces in the thyroids of guinea-pigs a proliferation of the parenchymatous tissue and more rarely of the interstitial tissues. G. M. F.

The Morphology of Pure Cultures of Hepatic Cells in vitro.—L. Doljanski ("Sur la morphologie des cultures pures des cellules hepatiques *in vitro*," *Compt. rend. de la Soc. de Biol.*, 1929, **102**, 629–31). The cultures consisted of the livers of week-old embryo chicks. Cytologically the cells resemble typical liver cells both in their general arrangement and in their protoplasmic inclusions. The formation of bile and glycogen is, however, inhibited while fat accumulates in the cells. G. M. F.

Ectopic Cone Nuclei.—A. M. Culler and G. L. Walls (*Arch. Ophthalmol.*, 1930, **3**, 736–43, 2 text-figs.). The occurrence in normal human retinæ of cone nuclei outside the external limiting membrane is explained as a developmental anomaly produced by a minor disturbance of the time relation between the differentiation of the cones and the formation of the external limiting membrane. All the characteristics of the anomaly are thus explained, including the distribution in man and in the lower animals, where, as in the bat, occasional ectopic rod nuclei occur in the cone-free retina, while in the lamprey, where the limitans is very thin, ectopic cone nuclei are common. G. M. F.

Mollusca.

Two New Tectibranchs from India.—C. H. O'Donoghue (*Proc. Malac. Soc.*, 1930, **19**, pt. 3, 83–90, 2 text-figs.). Unusually full and interesting descriptions, including radulæ. E. W. B.

Additional Notes on Bivalves' Brains.—H. Watson (*Proc. Malac. Soc.*, 1930, **19**, pt. 3, 139, 140). Watson had previously (pp. 31–6 of same volume) drawn attention to Dakin's discovery regarding the central nervous system of *Spondylus*, but with certain reservations, which appear to have phylogenetic importance. He now explains further, and quotes from a letter received from Pelseneer, who supports his view, and shows that in the Limidæ the evolution of the central nervous system has followed the lines which Watson suggested for *Spondylus*.

E. W. B.

Abnormal Forms of Limnæa peregra obtained in Artificial Breeding, and their Inheritance.—A. E. Boycott and C. Diver (*Proc. Malac. Soc.*, 1930,

19, pt. 3, 141–6, 3 pls., 1 text-fig.). These abnormal forms, which are here frankly regarded as monsters (though only the characters of the shells are discussed), are a by-product of Prof. Boycott's great breeding experiment with the Leeds sinistral race of *L. peregra.* As a result, we find that there is ground for supposing that scalariformity, or scalarescence, is to some extent a heritable quality. The other forms are of interest as showing analogies with allied forms in the same genus. The pictures are certainly wonderful, and would have been the delight of old-fashioned naturalists anxious to discover "missing links"; they would have created much excitement if they had been published before 1859. Unfortunately, the most planorboid and involutiform produced, when they bred, only normal offspring. E. W. B.

Revision of the Asiatic Species of the Genus Corbicula, IV.—B. Prashad (*Mem. Ind. Mus.*, **95**, 193–203, 3 pls.). In this part Dr. Prashad treats of Corbiculæ from the Sunda Islands, the Celebes, and New Guinea. He has had the advantage of examining most of the previously described types, and has illustrated the group with admirable photographs. E. W. B.

Preliminary Note on Entovalva Semperi sp. nov., a Commensal Bivalve living attached to the Body of a Synaptid.—Hiroshi Ohshima (*Annotationes Zoologicæ Japonenses*, 1930, **13**, 25–7, 1 pl.). The author hesitates to accept the new generic name *Devonia* proposed by Winckworth. The species in question is probably closely allied to a Philippine form briefly mentioned by Semper. E. W. B.

Marine Mollusca of the Shores and Shallow Waters of County Dublin.—Nathaniel Colgan (*Proc. Roy. Irish Acad.*, **39**, B 17, 391–424). This is a posthumous work. Mr. Colgan's researches were carried out in 1905–14. The section of Opisthobranchs appeared in the *Irish Naturalist* for the latter year. The remainder has been abbreviated here. No additions to the list are known to have been made since 1914. Colgan describes Turton's researches of a century earlier. In later lists comparative frequencies are not indicated, and fossil and deep-sea forms are included. The foreshore is described, the literature catalogued, and rare occurrences are specified, with references and critical remarks.
E. W. B.

Catalogue of the Land-Shells of Victoria.—C. J. Gabriel (*Proc. Roy. Soc., Victoria*, 1930, **43**, 1, 62–88, 2 pls.). The author gives synonymy, measurements, localities, and observations under each species. Eight new species are described. The following are recorded as naturalized species :—*Limax maximus, flavus, agrestis*; *Milax gagates*; *Vitrea cellaria*; *Zonitoides nitidus*; *Helicella caperata, barbara*; *Helix pisana, aspersa*; *Hyalina fulva.* E. W. B.

Insecta.

Australian Diptera.—J. R. Malloch ("Notes on Australian Diptera, XXV," *Proc. Linnean Soc., N.S.W.*, 1930, **55**, no. 230, pt. 4, 427–50, 18 text-figs). The present paper contains, besides some additional data from four families that have already been dealt with to some extent in this series, a revision of the species of the Calliphorid subfamily *Metopiinæ*, and some notes on *Empididæ*. The author has to a large extent recently neglected the former forms from Australia, of which he still has many submitted to him by the late Dr. E. W. Ferguson and others; but in view of the greater amount of interest generally evinced in the *Tachinidæ* and similar families, the author has deferred working up many species of such families as *Chloropidæ* that he has still before him. A large number of

new genera and species are described in this paper, and keys are given for their determination. M. E. M.

Australian Coleoptera.—A. M. Lea ("Descriptions of New Species of Australian Coleoptera, XXI," *Proc. Linnean Soc., N.S.W.*, 1930, **55**, no. 230, pt. 4, 451–67). In addition to truly Australian forms, five others from Fiji and Papua are herein described, but they are closely allied to Australian forms. In all, 23 descriptions of new species are given. M. E. M.

The Gall-Making Coccids.—W. W. Froggatt ("Notes on Gall-Making Coccids, with Descriptions of New Species, II," *Proc. Linnean Soc., N.S.W.*, 1930, **55**, no. 230, pt. 4, 468–74, 1 pl.). In this paper the author adds 5 new species to the genus *Apiomorpha*. Three of them, in the Coccid collection of the Queensland Museum, he has been able to study minutely. The female Coccids were examined (when possible) and measured before they were boiled in potash. The descriptions are made upon the examination of the cleared mounted specimens. The specific characters are based upon the form and arrangement of the chitinous bands, spines and hairs, upon the dorsal surface of the derm, and the structure of the anal appendages, which are very constant and distinct. Notes are included on the exact locality and range of several species, and records are given of the specific names of the Eucalypts upon which they develop, which were previously undetermined. M. E. M.

The Phenology of Crop Pests.—L. R. Tehon ("Methods and Principles for Interpreting the Phenology of Crop Pests," *Pub. State of Illinois Dept. of Registration & Education*, 1928, **17**, art. ix, 321–46, 18 text-figs.). The dominating influence exerted by weather and climate in determining the occurrence and distribution of phytopathogenes and phytophages, as well as the extent and the intensity of their attacks, is so conspicuous that it receives general recognition. Much effort has been expended in trying to determine experimentally, with the aid of accurately regulated laboratory apparatus, the manner in which temperature and moisture, the two chief elements, operate. While such work has considerable erudite value, it is to a large extent incapable of being applied from the practical standpoint to the immediate and pressing problems of the farm and orchard. In the present state of affairs this paper proposes primarily to call attention to a method of defining the relations of plant diseases to climate and weather, to make additional suggestions which may be useful to entomologists, and to point out some of the fundamental principles concerned. The schematic indication here used to depict climate and weather is not new, for it appears to have been originated by Ball (1910), and to have received its first application to practical problems in the hands of Taylor in 1916; but certain of its representations which are new are shown in the latter part of this paper. Being concerned with temperature and rainfall, it has been termed a hythergraph. A variation of the system which makes use of temperature and relative humidity is known as a climograph, for the reason that relative humidity, resulting from the influence of light, wind, and other lesser factors, as well as heat and rain, is considered to be a more exact expression of climate; but as records of relative humidity are often not readily available, the author states that it cannot be used with the same facility as the hythergraph. Essentially the schematic representation of the variables consists in the formation and interpretation of two- and three-dimensional graphs. If, as the author indicates, certain sections of the paper should appear to readers to be lacking in conclusiveness, the author's response is that his aim has not been so much to draw final conclusions as to illustrate the potentialities of the method. M. E. M.

Indian Jassidæ.—H. S. Piuthi ("Studies on Indian *Jassidæ* (*Homoptera*)," *Mem. Ind. Mus.*, 1930, **11**, no. 1, 1–68, 5 pls., 92 text-figs.). All *Jassidæ* without exception seem to live on plant-sap, which they suck by means of their proboscides. Their chief food plants are the cereals, but they also attack other important crops, such as cotton, and valuable orchards, like those of apple and mango. They not only decrease the yield of their hosts, but seriously affect the quality of what they leave. Besides directly damaging the crops by draining them of their sap, they act as carriers of several serious virus diseases of plants, e.g., tip-burn of potatoes, leaf-curl of sugar beet, etc. This group of insignificant insects is, therefore, of great economic importance, especially in an agricultural country such as India. The study of Indian *Jassidæ* has attracted the attention of very few workers. Atkinson, in 1885, enumerated 38 species only of this group, but remarked correctly that the number of *Jassidæ* awaiting collection should add several hundred species to the Indian fauna. In the present paper the author includes descriptions of 41 new species, redescriptions of 3 previously described species, and the description of 5 new genera. M. E. M.

New Cordyluridæ and Dryomyzidæ.—F. Hendel ("Entomologische Ergebnisse der schwedischen Kamtchatka-Expedition, 1920–1922, 28, *Diptera Brachycera* 2, Fam. *Cordyluridæ* und *Dryomyzidæ*," *Arkiv för Zoologie*, 1930, **21**, 3, no. 18, 1–12. This paper principally consists in the description of 9 new species belonging to the *Cordyluridæ*, and the record of *Neuroctena anilis* Fall, of the *Dryomyzidæ*. M. E. M.

Bombinæ (Hymenoptera).—H. Bischoff ("Entomologische Ergebnisse der schwedischen Kamtchatka-Expedition, 1920–1922, 29, *Bombinæ* (*Hymen*)," *Arkiv för Zoologie*, 1930, **21**, 3, no. 19, 1–6. A list of the records is the principal subject-matter of this paper. M. E. M.

Philippine Tipulidæ.—C. P. Alexander ("New or Little-known *Tipulidæ* from the Philippines (*Diptera*), VII," *Philippine J. Sci.*, **43**, no. 2, 277–301, 2 pls.). As before, the present report is based entirely on important collections of Crane-flies received from Mr. Richard C. McGregor. The most important series include material taken in Cagayan Province, north-eastern Luzon, in April and May, 1929, by Mr. F. Rivera, and further collections made at, and above, Ube, Laguna Province, at the foot of Mount Banahao by Messrs. McGregor, Duyag, and Rivera. Under the methods of collecting employed, the knowledge of the Tipulid fauna of Luzon is developing very rapidly. Descriptions and keys for the identification of 19 new species are given. M. E. M.

Control of Reproduction in Aphids.—F. Shull ("Control of Gamic and Parthogenetic Reproduction in Winged Aphids by Temperature and Light," *Zeits. für induktive Abstammungs und Vererbungslehre*, 1930, **55**, 1/2, 108–26). High temperatures (24° C. or above), applied to winged aphids of the species used, tend to make the offspring of those aphids parthenogenetic females. Low temperatures (16° C. or below) tended to make the offspring gamic females. Continuous light applied to winged aphids tended to make their offspring parthenogenetic; alternating light and darkness tended to make them gamic. The effectiveness of light varied with the temperature. Thus at 16° C. there was practically no difference between continuous light and alternating light and darkness, but at 22–28° C. the continuous light was distinctly favourable to the parthenogenetic offspring. Light was much less effective than temperature, however. The mode of reproduction was found to be decided for any individual before birth. Light

and temperature did not change it thereafter. High temperature applied to winged parents immediately after birth, for periods varying from 6 to 16 days, produced parthenogenetic offspring in increasing numbers with increasing duration of high temperature. These numbers were, in general, larger in March than in January. High temperature for only three days after birth had no effect on the nature of the offspring. A nearly complete change from parthenogenetic offspring to gamic offspring, by rearing the winged parents at low temperature, much or all of the time, was effected in about five weeks (in May and June). A possible explanation for both the determination of the two types of individual and the rate of development would be that a large or small quantity of some substance differentiates parthenogenetic and gamic females, and that development is rapid only when this quantity is distinctly high or low, but slow when the quantity is intermediate.

M. E. M.

Philippine Variety of Anopheles aconitus.—C. Manalang ("Morphology and Classification of the Philippine Variety of *Anopheles aconitus* Donitz, 1902, and *Anopheles minimus* Theobald, 1901," *Philippine J. Sci.*, 1930, **43**, no. 2, 247–60, 1 pl.). The author presents a brief review of the literature on the Philippine *Anopheles funestus* group, and of the rulings on the nomenclature. A morphological study of a series of adult mosquitoes of this group, and the larval skins from which they were bred out, is described and discussed. Additionally, he shows, by the consideration of the principal characters of the local mosquitoes and those described from Ceylon, Assam, Java, and Malaya, that there exists a variety of *aconitus* (*filipinæ* n. var.) in the Philippines which has heretofore been classified as varieties of *A. minimus* Theobald. The opinion is also expressed that the local *minimus* is identical with *Anopheles funestus* Giles, 1900, amended by Strickland in 1924.

M. E. M.

Philippine Carpenter Bees.—T. D. A. Cockerell ("The Xylocopid or Carpenter Bees of the Philippine Islands," *Philippine J. Sci.*, 1930, **43**, no. 2, 265–75). In the Philippine Islands, as in other parts of the Oriental region and throughout Tropical Africa, two genera are found. One, *Mesotrichia* Westwood, has the hind part of the thorax flattened, as well as possessing other conspicuous characters. In the other genus, *Xylocopa*, the thorax is rounded, as in other bees. Members of the Philippine family *Xylocopidæ* are fairly numerous, and on the whole are very closely allied to species of the nearest parts of Asia. There is evidently a tendency to develop insular species or races, and it is probable that many more of these will be discovered on the islands which have not yet been explored for bees. In the present paper *Mestorichia cuernosensis* is recorded from Cebu, being the first to be reported from that island. Also at Uling, Cebu, September, 1925, A. Duyag collected *Apis binghami* Cockerell. There is a curious parallelism between the modification of the Philippine Xylocopids and those of Africa. Descriptions are given of the species, and keys are provided for their identification.

M. E. M.

The Stone-Flies of Illinois.—T. H. Frison ("Fall and Winter Stone-Flies, or *Plecoptera*, of Illinois," *Publ. Dept. of Registration & Education, State of Illinois*, 1929, **18**, art. 2, 345–409, 77 text-figs.). In this paper are presented the results of an investigation of the biological and systematical characteristics of 5 genera, comprising 11 species, of the little-known Fall and Winter Stone-flies occurring in Illinois. It has been found that these species differ biologically from one another in respect to their seasonal adjustments, the habitats they prefer, oviposition, and in many other details of their life-histories. In opposition to

general ideas concerning the food habits of the order as a whole, the adults as well as the nymphs were found to be herbivorous. Because of a previous erroneous designation of a genotype, it has been necessary to replace the generic name of *Nephelopteryx* Klabalek with *Tæniopteryx* Pictet (*sensu str.*), to revive the name of *Brachyptera* for another generic complex, perhaps endemic to the Palæarctic fauna, to substitute *Tænionema* Banks for a Nearctic complex, and to erect a new Nearctic genus, *Strophopteryx*. In order to facilitate the determination of the Illinois species, keys for the determination of the adults and nymphs of genera and species have been formulated, systematical and distributional information has been presented for each species, and 3 species new to science have been described—*Allocapnia mystica*, *Allocapnia forbesi*, and *Leuctra claasseni*. M. E. M.

Larval Scarabæoidæ.—W. P. Hayes ("Morphology, Taxonomy, and a Biology of Larval *Scarabæoidæ*," *Illinois Biological Monographs*, 1929, **12**, no. 2, 7–119, 15 pls.). This extensive paper comprises the study of the larvæ of North American *Lamellicornia*, including the now recognized families—*Scarabæidæ*, *Lucanidæ*, *Trogidæ*, and *Passalidæ*—and attempts to bring together our knowledge of their biology, including the writer's life-history studies, and presents keys for their identification based on morphological studies. No comparative studies of the structural characters of these insects have hitherto been attempted, and it is hoped that this work, though far from being complete, will afford a stepping-stone to further progress in our knowledge of the group. For taxonomic purposes the characters of the mouth-parts and the last abdominal segment have proved the most useful. The analytical tables can be considered as only preliminary, inasmuch as a great many of the species are still unknown in the larval stages. The long life-cycle of many species makes rearing very difficult. In the discussion given to biology there have been brought together, in a comparative manner the more general facts concerning post-embryonic development. Some consideration is given to the late-embryonic processes, and the larval development is considered in a general way, as is also pupal development. This is followed by more detailed life-history studies in the subfamilies *Melolonthinæ*, *Rutelinæ*, *Dynastinæ*, *Cetoniinæ*, and the coprophagous species of the family *Scarabæidæ*. M. E. M.

New Australian Hymenoptera.—A. P. Dodd ("New Hymenoptera Proctotrypoidea from Victoria," *Proc. Roy. Soc., Victoria*, **43**, N.S., pt. 1, 26–35). The material from which this paper was prepared was submitted by Mr. F. E. Wilson. Six new species are proposed, 3 of which are placed in *Xenotoma* Fœrster, a Belytid genus not previously recognized in Australia. In addition, the males of *Prosoxylabis pictipennis* Dodd (*Belytidæ*), *Neobetyla spinosa* Dodd (*Belytidæ*), and *Hemilexomyia abrupta* Dodd (*Diapriidæ*) are made known. M. E. M.

New Bees.—T. Rayment ("New and Remarkable Bees," *Proc. Roy. Soc., Victoria*, 1930, **43**, N.S., pt. 1, 42–61, 8 text-figs.). Descriptions are given, with biological notes, of the following new species :—*Neopasiphæ insignis* n. sp. ; *Meroglossa miranda* n. sp. ; *Paracolletes picta* n. sp. ; *Paracolletes maculatus* n. sp. ; *Andrenopsis wilsoni* n. sp. ; *Paracolletes rufa* n. sp. ; *Neoceratina rubinii* n. sp.; *Trigona cockerelli* n. sp. M. E. M.

The Hessian Fly and Wheat Crop.—W. P. Flint and W. H. Larrimer ("The Hessian Fly and the Illinois Wheat Crop," *Publ. Dept. Registration & Education, State of Illinois*, 1928, **17**, art. xi, 363–85, 13 text-figs.). The Hessian fly, an insect which infests practically all of the large wheat-growing areas of the world, was first found in North America on Long Island in 1779, and was probably

imported in straw used by the Hessian troops during the Revolutionary War. It was first recorded in Illinois in 1884, according to Webster, and it has been a factor in wheat production in this State ever since. By the aid of tables the author shows the average yield of wheat obtained from all seedings made before and from all those made after the normal relatively fly-free date for each of the named localities. In most cases the increase in yield from the later seedings compared with the earlier seedings is marked. The increase does not involve any increase in additional labour or any expenditure for fertilizer or any other outlay. The tables also show the average per cent. infestation by the Hessian fly in these two groups of seedings, indicating that the wheat sown after the relatively fly-free date has not been sufficiently infested at any point over the period to cause a marked decline in the yield. Early seeding does not produce high yields of wheat on the average. The same is true of very late seeding. In years when the Hessian fly is abundant it is almost sure to cause a very marked decrease in yield from wheat sown early. The results obtained from experimental plots in such years are summarized, showing that the difference between the yields from wheat sown before the fly-free date and after this date has averaged more than 5 bushels per acre. M. E. M.

Australian Trichopterygidæ.—C. DEANE ("Trichopterygidæ of Australia and Tasmania," *Proc. Linnean Soc., N.S.W.*, 1930, **55**, no. 230, pt. 4, 477–90, 22 text-figs.). The only species belonging to this family of minute Coleopterous insects previously described from Australia are 6 species, by A. M. Lea, in the genus *Rodwayia* Lea, 1907, and 1 each from the genera *Actinopteryx*, 1872, and *Ptilium*, 1878, by Mathews. With the material sent to the author by the authorities of the South Australian Museum for identification, and other material which has been collected, it is probable that the numbers will be largely increased. The author hopes to deal with these and some island forms in subsequent papers. One of the chief points of interest centering around this group is the fringe formation of the wings, the hairs composing the fringe often extending completely and uniformly around both anterior and posterior margins as well as the apex. The length of these hairs is sometimes ten times as great as the width of the membrane. A total of 6 new genera and 11 new species is included in this paper, of which descriptive accounts are given. M. E. M.

Australian Diptera.—J. R. MALLOCH ("Notes on Australian Diptera, XXVI," *Proc. Linnean Soc., N.S.W.*, 1930, **55**, no. 230, pt. 4, 488–92, 3 text-figs.). For the information of Australian students of the Acalyptrate Diptera, the author presents a key to all the genera of the family *Ochthiphilidæ*, many of which are not as yet represented in the material from Australia, which the author has studied personally. A key to the species is also provided, and descriptions are given of 2 new species. M. E. M.

New Ants.—J. CLARK ("New Formicidæ, with Notes on some Little-Known Species," *Proc. Roy. Soc. Victoria*, 1930, **43**, N.S., pt. 1, 2–24, 1 text-fig.). Descriptions are given of 14 new species and the female of a previously described species. A new genus, *Eubothroponera*, has been erected to contain 3 species which cannot be placed satisfactorily elsewhere. This genus is close to *Bothroponera* Mayr. Owing to the confusion which has surrounded the ants collected by the members of the Horn Expedition, and described by W. F. Kirby (Horn Expedition, 1896, **1**, suppl., 203–7), it has been considered advisable to review the types in the National Museum collection. It is considered that the identifications and descriptions therein are worthless, and none of the species are recorded by Emery in the Genera Insectorum. There appear to be 5 valid species among the material. These,

with the exception of *Iridomyrmex flavipes*, have been redescribed. Forel's description of *I. rostrinotus* (= *I. flavipes* Kirby) is too complete to warrant further detail. M. E. M.

Rotifera.

New Rotifers from Poland.—J. Wiszniewski ("Zwei neue Rädertierarten: Pedalia intermedia n. sp. und Paradicranophorus limosus n.g. n. sp.," *Bull. Acad. Pol. Sci. Let.*, 1929, 137–53, 1 pl.). The author describes as new to science two species of Rotifers found in the vicinity of Warsaw. One of these is a member of the famous genus Pedalia (better known, perhaps, under its original name, Pedalion), for which Hudson created his fourth order of the class Rotifera, the order Scirtopoda, no longer regarded as valuable. The genus is now held to be a true representative of the order Ploïma and is placed in the family Filiniidæ As the specific name indicates, this fourth species of the genus is structurally intermediate between the forms already known, yet it is most likely to be passed over as being the widely distributed *P. mira*, from which it less obviously differs. It possesses the pair of posterior processes hitherto believed to be solely characteristic of that species, but differs from it in having no lip to the corona and one tooth less on the uncus, whilst the bristles on the dorsal limb are in pairs, and the ventral limb is not longer than the body. These details justify the creation of the new species, but they will require very careful scrutiny for their recognition. The second species found is only new to Poland, since it proves to be identical with that described by Miss Glascott in 1893 and named *Diglena hudsoni*. In a recent note in this Journal (December, 1929, p. 321), Prof. de Beauchamp has recorded its presence in Surrey, and has described the male, which had not been detected previously, and has given additional details regarding the female. The species now stands as the type (monotype) of the new genus Paradicranophorus of Wiszniewski, retaining its specific name *Hudsoni* (Glascott). Its discovery so far away as Poland from its first known habitat in Ireland is particularly interesting. D. L. B.

Protozoa.

The Virulence of the Dysentery Amœba.—L. R. Cleveland and E. P. Sanders ("The Virulence of a Pure Line and Several Strains of *Entamœba histolytica* for the Liver of Cats, and the Relation of Bacteria, Cultivation and Liver Passage to Virulence," *Amer. Journ. Hyg.*, 1930, **12**, 569–605). *Entamœba histolytica* was cultivated in a medium of liver infusion agar slants covered with sterile horse serum and saline (1 : 6) with a small amount of sterile rice. Inoculations of 0·5 cc. of culture, containing 5–7 million amœbæ, made into the liver of cats following laparotomy, produced typical amœbic abscesses. The experiments were conducted with the view of determining the virulence of amœbæ for the liver. It was found that after cultivation for a year the amœbæ lost most of their ability to maintain themselves in the liver; this power could, however, be gradually restored by successive passages through the liver. It was also shown that abscesses develop only in the presence of certain bacteria accompanying the amœbæ in cultures, none of the animals inoculated with bacteria-free cultures or with amœbæ and non-pathogenic bacteria being capable of producing abscesses. C. A. H.

Flagellates from Termites.—H. Kirby, Jr. ("Trichomonad Flagellates from Termites. I. *Tricercomitus* gen. nov., and *Hexamastix* Alexeieff," *Univ. Calif. Pub. Zool.*, 1930, **33**, 393–444, 5 pls., 4 text-figs.). A new type of polymastigote flagellates, *Tricercomitus* gen. n., is described from termites, with two species,

T. termopsidis sp. n., from *Termopsis*, and *T. divergens* sp. n., from various Kalotermitinæ. To this genus belong small flagellates with three anterior flagella, a very long trailing flagellum adhering to the body and free at the posterior end of the body, nucleus anterior, large blepharoplast with a parabasal body and a fine axostyle. The "*Trimitus*-forms" of *Janickiella* and *Devescovina* described by Duboscq and Grassé are referred to the new genus. Three new species of *Hexamastix*, *H. claviger*, *H. conclaviger*, and *H. disclaviger*, are described from Kalotermitinæ. These all have the five anterior flagella united into a long whip-like structure. Two other new species, *H. termopsidis* and *H. laticeps*, were found in *Termopsis*, and differ from the above three species in the structure of their nucleus. C. A. H.

Effect of Splenectomy in Piroplasmosis.—E. Brumpt ("Rechutes parasitaires intenses, dues à la splénectomie, au cours d'infections latentes à *Ægyptianella*, chez la poule," *C. R. Acad. Sci.*, 1930, **191**, 1028–30). It is known that in the case of latent infections with piroplasms the removal of the spleen in the host frequently brings about a relapse, the parasite rapidly increasing in numbers and sometimes killing its host. The author studied the effect of splenectomy upon fowls that had previously been heavily infected with a parasite related to *Anaplasma*, *Ægyptianella granulosa* (Balfour, 1911) (= *Ae. pullorum* Carpano, 1929), but had afterwards ceased to show any parasites in their blood. After the operation the parasites reappeared and increased in numbers, but the infection later died out and the fowls recovered. C. A. H.

A New Rodent Coccidium.—F. Fish ("Coccidia of rodents: *Eimeria monacis* n. sp., from the Woodchuck," *J. Parasitol.*, 1930, **17**, 98–100, 1 pl.). A coccidium, named *Eimeria monacis* sp. n., was found in the fæces of the common woodchuck, *Marmota monacis*, sub-sp. *monax*, in U.S.A. (Washington). The oocysts measure $16 \cdot 8$–$23 \cdot 2\mu$ in length, $15 \cdot 2$–$21 \cdot 1\mu$ in breadth. There are both oocystic and sporocystic residues. C. A. H.

Neuromotor Apparatus in Ciliates.—C. W. Rees ("Is there a Neuromotor Apparatus in *Diplodinium ecaudatum*?" *Science*, 1930, **71**, 369–70). *Diplodinium ecaudatum* was re-studied by the author with special reference to the neuromotor apparatus as described by Sharp (1914). The staining technique for sections was the same as Sharp's. After a detailed study of the structures as found by himself, the author questions the correctness of Sharp's interpretation of the neuromotor apparatus, and believes that "the motorium is a fold of an ectoplasmatic layer which forms a cylinder surrounding the œsophagus and also underlies the ciliary rootlets of the membranelles." C. A. H.

Pipette for Protozoa.—E. P. Jones ("A Foot-Operated Pipette for Protozoans," *Trans. Amer. Micr. Soc.*, 1930, **49**, 348). The author recommends a simple apparatus for counting, picking up, or expelling protozoa observed under a binocular. The device consists of a 7-foot length of ¼-inch rubber tubing as used for Bunsen burners; one end of this is made airtight by folding it over and tying it with strong thread, or by vulcanizing; to the other end is fitted a pipette made from 7 mm. glass tubing. The apparatus is worked by the foot and, while perfectly efficient, can be used for a long time without fatigue. C. A. H.

Freshwater Dinoflagellates.—E. Eddy ("The Freshwater Armoured or Thecate Dinoflagellates," *Trans. Amer. Micr. Soc.*, 1930, **49**, 277–321, 8 pls.). A description of the freshwater species of dinoflagellates bearing a definite membrane ("armoured") and included in the class Peridinales or the order Dinoflagellida.

An introductory account is given of the general organization of these flagellates and of the previous literature. In the present paper are recorded forms collected by the author in the United States, which are described, together with other known species of this group. A short diagnostic description, illustrated by black-and-white figures, together with a note on distribution, are given for each species. The species known to occur in U.S.A. are as follows :—*Hemidinium nasutum, Glenodinium cinctum, G. dybowski, G. gymnodinium, G. pulvisculus, Gonyaulax palustre, Peridinium cinctum, P. cunningtoni, P. pusillum, P. quadridens, P. tabulatum, P. umbonatum, P. volzi, P. willei, P. wisconsinense* sp. n., *Ceratium hirundinella.*
C. A. H.

A Trichomonad of the Turkey.—F. VOLKMAR (" *Trichomonas diversa* n. sp., and its Association with a Disease of Turkeys," *J. Parasitol.*, 1930, **17**, 85–9, 2 text-figs.). A new flagellate, *Trichomonas diversa* sp. n., was found parasitic in the lumen of the upper part of the digestive tract of turkeys in U.S.A. This species measures about 14 by 9μ. The presence of the parasite seems to be associated with definite lesions of the mucous membrane of the region inhabited by it. C. A. H.

A New Amœba from a Turtle.—E. P. SANDERS and L. R. CLEVELAND (" The Morphology and Life-Cycle of *Entamœba terrapinæ* spec. nov., from the Terrapin, *Chrysemys elegans*," *Arch. f. Protistenk.*, 1930, **70**, 267–72, 1 pl.). Description of a new amœba, *Entamœba terrapinæ* sp. n., from the turtle, *Chrysemys elegans*. It is a small amœba, the free stage of which measures 10–15μ in diameter, and the cysts 8–14μ. The nucleus is typical of the genus. The amœba grew readily in cultures at room temperature (liver infusion agar slants with horse serum-saline or turtle serum-saline, to which rice was added.) The cysts develop to a 4-nucleate stage. A 4-nucleate excysted amœba gives rise by division to two binucleate ones, which by further division produce four uninucleate amœbæ. Excystation takes place at 27° C. C. A. H.

An Amœba in Yeast Cultures.—Sir A. CASTELLANI (" An Amœba found in Cultures of a Yeast," *J. Trop. Med. & Hyg.*, 1930, **30**, 160, 1 pl., 188–191, 5 text-figs., 221–2, 1 pl., 237, 2 text-figs.). An amœba was found growing in glucose-agar cultures of a yeast-like fungus (*Cryptococcus pararoseus*). The dimensions of the amœba varied from 13·5 to 22·5μ. The cysts have thick membranes with a wavy contour, and measure 9–12μ in diameter. The nucleus is said to have a " nucleolus " [? karyosome]. Typical pseudopodia are formed, and sometimes the surface is seen to be covered with hair-like ectoplasmic processes [filopodia]. It is stated that " the amœba seems to live a strictly parasitic life on fungi and bacteria." It is obvious, however, that the term " parasitic " is misapplied, since there is no evidence that the amœba lives at the expense of any animal or vegetable *host*. The fact that " it is not capable of living on ordinary media . . . which contain neither fungi nor bacteria," only shows that the amœba is not saprozoic, but a holozoic free-living organism. The amœba was grown successfully in pure culture with killed *Bacillus typhosus* and other micro-organisms. C. A. H.

A New Coccidium from a Ground-Squirrel.—J. A. KARTCHNER and E. R. BECKER (" Observations on *Eimeria citelli*, a New Species of Coccidium from the Striped Ground-Squirrel," *J. Parasitol.*, 1930, **17**, 90–4, 1 pl., 2 graphs). Description of a coccidium, *Eimeria citelli* sp. n., from the epithelium of the cæcal mucous membrane of *Citellus tridecemlineatus*, in U.S.A. The oocysts measure 15–23μ in length by 14–19μ in breadth. After 72 hours of exogenous development the sporocysts with sporozoites are produced, leaving a large oocystic residue which

may disappear later. The sporocyst measures 5·2–9μ by 3·9–7μ, and contains a residual body. Some observations on experimental infections with this coccidium are described. C. A. H.

Ciliates from Cattle and Pig.—C. W. REES ("Studies on the Morphology and Behaviour of *Buxtonella sulcata* from Cattle and of *Balantidium coli* from the Pig," *J. Parasitol.*, 1930, **22**, 314-25, 1 pl., 6 text-figs). *Buxtonella sulcata* Jameson was found in 25 p.c. of cattle in Louisiana, U.S.A. Its general morphology and minute structure are described. The cytostome is situated near the cytopyge, within a peristome running from the oral to the aboral end. Cysts were recovered from the cow's fæces. It is proposed to remove this ciliate from the class Aspirigera (Holotrichida) to the Spirigera (Heterotrichida). Observations on *Balantidium coli* of the pig confirmed most of McDonald's findings, but the oral plug and the centralized neuromotor system described by him could not be differentiated. In the course of the work a special micro-isolation pipette was used, consisting of two small pieces of glass tubing connected by a small piece of rubber tubing; one piece is sealed at its free end, and the other is drawn out at one end to a capillary and bent twice at obtuse angles. C. A. H.

Differentiation of Hæmoflagellates by Cultural Methods.—L. R. CLEVELAND and J. COLLIER ("The Cultivation and Differentiation of Hæmoflagellates in Autoclaved Media," *Amer. J. Hyg.*, 1930, **12**, 614–23). The various media usually employed for the cultivation of trypanosomes and allied forms have the common defect that some of the constituents cannot be autoclaved. The authors have sought to overcome this difficulty, and have grown hæmoflagellates in a series of 19 media (all of which are described) which had been wholly autoclaved. It was found possible to differentiate the various flagellates according to their requirements and behaviour in various media. The results are given in three tables. In this way six groups could be differentiated: (1) *Leishmania* (*infantum*, *tropica*), (2) *Herpetomonas muscarum*, (3) *Trypanosoma rotatorium*, (4) *T. lewisi*, (5) *Leptomonas ctenocephali*, and (6) *L. oncopelti elmassiani*, *parva*, *media*, *lygæorum*, *culicidarum*. C. A. H.

Life-Cycle of the Dysentery Amœba.—L. R. CLEVELAND and E. P. SANDERS ("Encystation, Multiple Fission without Encystment, Excystation, Metacystic Development, and Variation in a Pure Line and Nine Strains of *Entamœba histolytica*," *Arch. f. Protistenk.*, 1930, **70**, 223–66, 7 pls., 8 text-figs.). The authors have isolated 9 strains of *Entamœba histolytica* in various media with the view of determining their relative merits. Different modifications were introduced, and the following was found to be the most satisfactory. It consisted of slants of liver infusion agar (prepared by Digestive Ferments Co., U.S.A.), covered with horse serum in saline (1 : 6) and a 3 mm. loopful of sterile rice flour added to each tube. In this medium the amœbæ grew abundantly. Pure lines were established and variations in their structure were studied. Fixation in unheated Schaudinn's fluid produced amœbæ with typical nuclei, but at 60° C. forms similar to Kofoid and Swezy's "*Councilmania dissimilis*" and "*Karyamœbina falcata*" were produced. These forms are therefore a typical *E. histolytica* produced by fixation at 60° C. Cysts were easily produced in culture, their production being caused by rapid growth for 24 hours or more without subculture, by the presence of rice flour, rice starch, or powdered unpolished rice, and by the presence of certain kinds of bacteria. The various stages of encystation and excystation are described and illustrated. Mature 4-nucleate cysts excyst at 37° C., the 4 nuclei of the excysted amœba giving rise by division to 8 metacystic nuclei, with the final

production of 8 metacystic amœbæ. These grow into trophozoites. This development varies considerably, there being 24 possible combinations of nuclear and cytoplasmic division, all of which are said to have been seen by the authors. The 8-nucleate cysts sometimes observed in *E. histolytica* are the result of encystation of binucleate trophozoites. This amœba may also undergo a process of development described as multiple fission without encystment. C. A. H.

Patellina and its Relations.—W. J. Parr and A. C. Collins (" Notes on Australian and New Zealand Foraminifera. No. 1. The Species of *Patellina* and *Patellinella*, with a Description of a New Genus, *Annulopatellina*," *Proc. Roy. Soc., Victoria*, 1930, **43**, N.S., pt. 1, 89–95, pl. iv). It is proposed to review the species of foraminifera found living and fossil in the Australian and New Zealand region, dealing with one or more related genera in each paper. They are of exceptional interest, as many of the species of the Eocene of the Paris Basin are found in the Oligocene and Miocene of Victoria, and some of them, or closely related forms, are still living on the Australian coast. Except *Patellina*, the genera now dealt with are confined to the Indo-Pacific region. The authors do not agree with Cushman in assigning the *Patellina* found in this region to *P. advena*, a species originally described from the American Oligocene, but regard it as *P. corrugata*, the genotype, which has a world-wide distribution. A new species of *Patellinella*, *P. annectens*, is described from the Oligocene of Muddy Creek, Victoria, which is more primitive than the genotype *P. inconspicua*, which makes its first appearance in the Post Tertiary of Victoria, and is still living in Australian waters. A new genus, *Annulopatellina*, is created for the curiously depressed type which was originally described by Parker and Jones as *Orbitolina annularis*, and subsequently transferred by Carpenter to *Patellina*. The authors describe in detail the structure of both the megalospheric and microspheric forms, and regard the genus as confined to the western and southern shores of Australia. Plastogamy occurs, and in one locality, Hardwicke Bay, South Australia, plastogamic pairs are quite common. All the species described are adequately figured. A. E.

Mexican Eocene Foraminifera.—W. L. F. Nuttall (" Eocene Foraminifera from Mexico," *J. Palæont.*, 1930, **4**, (3), 271–93, pl. 23–5, map in text). The commoner foraminifera of the Chapacote (Upper Eocene) and Guayabal (Middle Eocene) formations of Mexico have already been described by Cushman and Cole. The term Aragon is here introduced for beds immediately underlying the Guayabal, which contain a fauna now described for the first time. The faunas of the three formations are distinct, and afford an illustration of the use of foraminifera in stratigraphy. The species of most value for recognition of each division are discussed, and their distribution shown in a table. Nine new species and four new varieties are described. The plates are very good. A. E.

New Genera.—J. A. Cushman (" A Résumé of New Genera of the Foraminifera erected since early 1928," *Cont. Cushman Lab. Foram. Res.*, 1930, no. 96, 73–94, pls. 10–12. Also issued as Special Publication No. 2, Cushman Laboratory, Sharon, Mass., price 50 cents). It is so hard to keep touch with the continuous output of foraminiferal literature, largely appearing in American journals not always accessible to European workers, that this publication supplies a much-needed requirement. Three new families and 43 new genera have been created in the last three years. The *résumé* contains modified descriptions of all of them, and in nearly every case a copy of the original figures. The genera are placed in their proper order under the Cushman system of classification, and the position of the new families is also indicated. A. E.

Pleistocene of Maryland.—J. A. CUSHMAN and W. STORRS COLE ("Pleistocene Foraminifera from Maryland," *Cont. Cush. Lab. Foram. Res.*, 1930, no. 97, 94–100, 1 pl.). Only four species of foraminifera have hitherto been recorded from these deposits, but when fresh material was obtained from two different localities, they proved to be rather common. The material indicates different conditions of temperature during deposition, some of the species being characteristic of comparatively warm waters and others being recognised cold-water forms. All the 13 species and varieties figured and described are still living, and the specimens were found to be in a perfect state of preservation, often retaining their original colour. A. E.

Life-History of Polystomella crispa.—J. J. LISTER, edited by E. HERON-ALLEN ("The Further and Final Researches of Joseph Jackson Lister upon the Reproductive Processes of *Polystomella crispa* (Linné) (An Unpublished Paper, Completed and Edited from his Note Books)," *Smithsonian Misc. Coll.*, 1930, **82**, no. 9, 1–11, 7 pls.). The late J. J. Lister's work on the megalospheric stage of *Polystomella* was published by himself in 1895 in his celebrated communication to the Royal Society. This contained also a brief postscript containing an abstract of his observations on the reproduction of the microspheric form, later expanded in his well-known treatise on the Foraminifera (1903). For some reason he never published his observations at length. His journals, containing a day-to-day account of his work at Plymouth in 1894, have now been edited and illustrated with his own photographs taken at the time of the observations. A. E.

Lower Oligocene of Florida.—W. STORRS COLE ("The Foraminifera of the Marianna Limestone of Florida," *Florida State Geol. Surv.*, Bull. 5, 1930, 19–69, pls. 5–11). The limestone is a soft white homogeneous rock of lowest Oligocene age resting conformably on the Ocala limestone, which is uppermost Eocene, and containing up to 95 p.c. calcium carbonate in the purer beds. It attains a thickness of about 30 feet, and the author records 56 species and varieties of foraminifera, 6 of which are apparently new. While many of these range through the entire American Oligocene, 4 forms, viz., *Lepidocyclina mantelli* and its variety *papillata*, *Eponides mariannensis* and *Operculinella dia* sp. n., appear to be confined to the Marianna beds, and may be regarded as indicative of typical Marianna limestone. The paper is well illustrated, and there are two tables showing the local distribution of the recorded species in various exposures. A. E.

Palæozoic Foraminifera from Texas.—HELEN J. PLUMMER ("Calcareous Foraminifera in the Brownwood Shale near Bridgeport, Texas," *Univer. Texas Bull.* 3019, 1930, 5–21, 1 pl.). The Brownwood shale examined was compact, with hardly any trace of siliceous minerals. After treatment numerous foraminifera were obtained. The term "adventitious" is suggested by the author to include all shells composed of any extraneous material bound by cement. She uses "arenaceous" in its strict etymological sense for tests composed of mineral grains cemented by a protoplasmic secretion, and separates these from those having an investment composed largely of crystalline calcareous granules held together by calcareous cement. These latter were described by Brady as "sub-arenaceous," but the author doubts whether such tests are truly "adventitious," and thinks that the difference may have definite biological characters. She separates the foraminifera found in the Texas Pennsylvanian into three groups based on their shell composition: (1) Amorphous calcareous, e.g., *Cornuspira*, *Hemigordius*, etc.; (2) Granulo-crystalline calcareous, e.g., *Endothyra*, *Tetrataxis*, etc.; (3) Arenaceous, e.g., *Textularia*, *Reophax*, etc. There is an interesting section on isomorphism as a direct response of the organism to its environment or to the availability of extraneous

material, at least in these strata, in which she has discovered several isomorphous pairs. The chemical changes and deformational stresses which the tests have undergone in the long period since the deposition of these strata increase the difficulties of interpretation. The arenaceous tests have generally survived, but the amorphous calcareous tests are represented by casts in calcite or limonite, which in some cases have subsequently acquired an outer case of calcium carbonate. In other cases they have become entirely silicified. A new genus, *Earlandia*, and six new species are described and figured. A. E.

Further Palæozoic Foraminifera from Texas.—J. A. CUSHMAN and J. A. WATERS ("Foraminifera of the Cisco Group of Texas (exclusive of the Fusulinidæ)," *Univer. Texas Bull.* 3019, 1930, 22–81, pls. 2–12, 3 maps). The foraminifera of the Pennsylvanian and Permian of Texas have assumed great economic importance. The paper is intended as a preliminary one on which a better knowledge of the Upper Pennsylvanian group may be built, the Fusulinidæ being excluded as requiring study by a specialist. A large proportion of the foraminifera of the Cisco are simple arenaceous types. With the exception of some Miliolidæ and Opthalmidiidæ and one species of *Glyphostomella* which may or may not be related to the Nonionidæ, all the forms are stated to be arenaceous and decidedly primitive. None of the more highly developed families allied to the Rotaliidæ are present. In the shales containing the deeper water species the cement is ferruginous like that of many species now living under similar conditions, but in the shallower deposits many forms use a calcareous cement to bind together non-calcareous particles. The authors regard this as a necessary stage in the development of imperforate calcareous forms such as *Agathammina*, the most primitive of the Miliolidæ, which shows great similarity to *Glomospira* in the arenaceous group. The relationship of the primitive forms of the Opthalmidiidæ to the smoother forms of *Glomospira* is equally close and shows their derivation. The genera of the Opthalmidiidæ are all primitive, with various structures based on modifications of the simple coiled tube. Some of them, as *Plummerinella*, are complex in form but simple in their primitive structure. None of the higher and more complex orms, such as are developed in the Mesozoic and Cainozoic, occur in the Cisco formation. On the other hand, some specialized simple types apparently reach their climax in these strata and vanish with the Permian. Five new species are described. The paper is well and lavishly illustrated. A. E.

Living Foraminifera. — LOIS T. MARTIN ("Foraminifera from the Intertidal Zone of Monterey Bay, California," *Micropalæont. Bull.* (*Stanford University*), 1930, **2**, no. 3, 50–4, 1 pl.). Foraminifera were found abundantly in washings of *Ulva*, belonging to the four genera *Bolivina*, *Discorbis*, *Cibicides* and *Quinqueloculina*. *Discorbis* was most abundant and *Bolivina* least. The *Discorbis* is stated to have been identified as *D. isabelleana* (d'Orbigny), and was found to live and develop satisfactorily in glass dishes without the presence of the alga. Observations were made and recorded on the use made of the pseudopodia, speed of motion, growth of shell, and reproduction. It is stated that the pseudopodia are used mainly as organs of attachment. They may also serve for collection of food, as bodies which come in contact with them are held fast. Whether they serve for locomotion is doubtful, as specimens were observed to move when no pseudopodia were seen. When a *Discorbis* is turned on its dorsal side, it presently turns over on to its apertural side. The process is very gradual to the extent of raising itself on to the edge of the shell; after that it appears to lose balance and fall suddenly on the apertural side. The power of motion is considerable, but the animals are more active in the dark, and there does not appear to be any factor

deciding the direction of movement. Growth of the shell was observed in several specimens of *Discorbis*. One specimen, of which drawings are given, was collected on July 19. During 36 hours between July 24–26 it added two new chambers, another being formed on August 1, and yet another between August 3–4. Ten days later another chamber was added, the last growth occurring on September 1. Thus six chambers were added in 39 days. Further observations on reproduction include descriptions of megalospheric young produced by microspheric individuals of *Quinqueloculina* and *Discorbis*. Some instances of plastogamy in *Discorbis* were also observed, and it is recorded that the individuals of a pair, when purposely separated, came together again and fastened themselves so securely as to resist further displacement. A very modestly written paper containing valuable information on little-studied subjects. A. E.

A Monograph of the Foraminiferal Family Polymorphinidæ, Recent and Fossil.—J. A. Cushman and Yoshiaki Ozawa (*Proc. U.S. Nat. Mus.*, 1930, 77, art. 6, 1–185, pls. 1–40). This lavishly illustrated monograph must be studied in conjunction with an earlier paper by the same authors, published in 1929, in which the new system of classification is outlined ("Some Species of Fossil and Recent Polymorphinidæ found in Japan.—A Revision of Polymorphinidæ," *Jap. J. Geol. & Geog.*, 1929, **6**, nos. 3–4. See *J. Roy. Micr. Soc.*, **49**, 4, 398). The system is primarily based on an examination of the known types from what is, to all intents and purposes, a new point of view. Since d'Orbigny erected the genus *Polymorphina* in 1826, giving aboral end views of his earliest species, the authors point out that no one has taken this view into consideration, but have confined their figures to side and oral end views. On this aboral end view, and the arrangement of the subsequent chambers in a clockwise or anti-clockwise spiral, the authors base their revision. The details are not easily grasped even when expressed at length by the authors, and defy abstraction. The authors have devoted much time to the study of collections and type specimens. Where the latter could not be traced they have examined material from type localities, finding, as a rule, that published figures are not sufficiently accurate in details to be reliable. The results are sufficiently overwhelming in the raising of *Polymorphina* to family rank, the creation of many new genera, the annexation as a genus of *Glandulina* (hitherto regarded as a subgenus of *Nodosaria*), and the erection of about 70 new species and varieties. Admirable figures of all the accepted species are given, with full synonyms, and there is a list of forms which the authors reject as not *Polymorphinæ*. Time only can show whether such elaboration of systematization will not defeat its own purpose of facilitating the study of the group. Yoshiaki Ozawa died prematurely in December, 1929, and this monograph, very largely his work, will be his memorial and an indication of the loss which science sustains by his early death. A. E.

Choanoflagellates.—W. N. Ellis ("Recent Researches on the Choanoflagellata (Craspédomonadines) (Freshwater and Marine), with Description of New Genera and Species," *Ann. Soc. Roy. Zool. Belg.*, 1929, **60**, 49–88, 1 pl.). With the exception of G. Lapage's paper on *Codosiga botrytis* in the Q.J.M.S., 1925, very little work appears to have been done in this country on the Choanoflagellates since the issue of Saville Kent's "Manual of the Infusoria." This, perhaps, is scarcely to be wondered at, since the "collared monads," as they are sometimes called, are among the smallest of all animal types, and consequently very difficult to study. This paper by Mr. Ellis, which, although published in Belgium, is based on material collected by him near his home at Appledore, in North Devon, or sent

from the Plymouth and Port Erin Biological Stations, is therefore very welcome. It deals first with some interesting general questions concerning the Choanoflagellates, such as food inception, the characteristic collar, the tegumentary structures, reproduction, etc., and then with the description of a number of new genera and species. Food inception, it is said, takes place outside the collar just below its base by sarcodic protrusions which may or may not take the form of prehensile pseudopods. The mucous envelope plays no part in the ingestion of food, as has been maintained by some authors. In addition to visible bacteria, it is suggested that ultra-microscopic forms may also be a source of food in some cases. The collar is regarded as probably polyfilipodal (polyaxopodal) in structure, homologous with the wreath of filipodia in *Pteridomonas* and some other forms. In one or two cases a secondary collar has been observed, but not a double collar in the usually accepted sense. Mr. Ellis, in giving special attention to the marine and brackish water Choanoflagellates, appears to have struck an almost virgin biological field. No less than 12 new species belonging to 7 new genera are described, together with 5 new species belonging to the old genus *Salpingœca*. The new genera are *Dicraspedella* (very similar to *Codonosiga*, but with secondary collar); *Choanœca* (with large inverted umbrella-like collar and no flagellum in the adult); *Stephanœca* (genus created to receive *Salpingœca ampulla*, Kent, and three new species in which the cell, collar, and flagellum are completely surrounded by the lorica); *Diaphanœca* (completely enclosed as in the previous genus, but with the expanded portions of the lorica reversed and the cell apparently suspended by its collar); *Acanthœca* (with the mouth of the lorica bearing a circle of long spine-like setæ); *Diplœca* (genus created for certain species of *Salpingœca* and a new species characterised by the lorica being double, the outer thick and enveloping the thin inner lorica up to the base of its trumpet-shaped neck); *Pachysœca* (genus created for some other species of *Salpingœca* and two new species with thickened but simple lorica). The paper closes with some remarks on the genus *Lagenœca*, Kent, in which doubt is expressed as to its validity, the forms recorded under this generic name being possibly various species of *Salpingœca* in a detached and free swimming state. In a paper entitled " Remarques relatives au précédent travail de W. N. Ellis " (*Ann. Soc. Roy. Zool. Belg.*, 1929, **60**, 89–95, text-figs.), Dr. H. De Saedeleer offers some observations and criticisms upon certain views expressed by Mr. Ellis. Naturally these will require careful consideration by all those reading the original paper. D. J. S.

BOTANY.

(*Under the direction of* A. B. RENDLE, D.Sc., F.R.S.)

GENERAL.

Cytology.

Chiasmata in Fritillaria.—W. C. F. NEWTON and C. D. DARLINGTON ("*Fritillaria meleagris*: Chiasma-Formation and Distribution," *Journ. Genetics*, 1930, **22**, 1–14). *Fritillaria meleagris* has 12 pairs of chromosomes, 2 with median, 10 with more or less subterminal attachment constrictions. One pair has two constrictions. In the meiotic prophase chiasmata are not formed at random, but with greater frequency in the neighbourhood of the constriction. The two chromosome types are therefore distinguishable by the distribution of their chiasmata. There is no definite change in the relationships of the chromatids between diplotene and metaphase. The details of the relationships of the chromosomes are largely concealed during metaphase owing to their great contraction. A table of chiasma frequencies taken from metaphase side views is given. This and the separation at anaphase corroborate the chiasma interpretation of the structure of bivalent chromosomes at metaphase. It follows that chromosome behaviour at meiosis must be examined in relation to the possibility of differential frequency of chiasmata as well as of their movement after formation. A knowledge of these circumstances is essential prior to considering the analogy with crossing-over results in a particular species. J. L.

Parasyndesis in Balsamina and Campanula.—J. M. DE SOUZA VIOLANTE ("La parasyndèse dans *Balsamina hortensis* et *Campanula persicifolia*," *La Cellule*, 1929, **39**, 235–66). Prochromosomes are present in the somatic nuclei of *Balsamina hortensis*. At the onset of the meiotic prophase these prochromosomes are associated in pairs. These pairs or zygosomes are present in the haploid number. Reticulate threads then become attached to the zygosomes and lie parallel to one another. There is no true leptotene stage. In *Campanula persicifolia* there are no prochromosomes nor zygosomes, but the parallelism of threads is similar to that in *Balsamina*. When the chromosomes are first associated, the threads are very thin (prepachytene), becoming later typically thickened. All the nuclear stages, even through second contraction, exclude the possibility of telosynaptic pairing. It is probable that the first division is a reduction division, conforming to the heterohomotypic scheme. J. L.

Meiosis in Listera ovata.—P. STANER ("Préréduction ou postréduction dans *Listera ovata* R. Br.," *La Cellule*, 1929, **39**, 219–29). The haploid chromosome number in *Listera ovata* is 17. Three of the gemini are of large size, corresponding to the six long somatic chromosomes. The gemini are not formed by telosynapsis: the two limbs are produced by a doubling back of the pachytene threads. The gemini in diakinesis often have the "ring form," the two chromosomes being

attached either at one end or at both ends by a thin chromatic double filament, indicating the double nature of each of the chromosomes. The gemini have never been found associated in chains. From diakinesis to anaphase the two-armed nature of the gemini becomes indistinct. The double nature of the anaphase chromosomes appears late, and in second prophase the chromosomes are in the usual form of an X or V. From these observations it is impossible to form a definite opinion in favour of either the pre-reduction or post-reduction interpretation of division. Possibly methods of technique are at fault. J. L.

Chromosomes of Rumex.—T. Ono ("Chromosomenmorphologie von *Rumex acetosa*," *Sci. Rep., Tôhoku Imp. Univ.*, 4th ser., 1930, **5**, 415–22). The chromosome formula for the normal male plant is 15 ($= X + 2Y + 12a$), that for the female 14 ($= 2X + 12a$). The morphological characters of the chromosomes are described. The autosomes all have one small head, and are indistinguishable from one another. One intersexual plant with 15 chromosomes is known. Its chromosome set is very like that of a normal male, except that one autosome (the a' chromosome) is characteristic. The formula for this plant is 15 ($= X + 2Y + a' + 11a$). Triploid plants with the following formula are known: 21 ($= 3X + 18a$), 22 $= (2X + 2Y + 18a)$ and 22 ($= 2X + 2Y + a' + 17a$). The first of these is female and never shows the a' chromosome; the last two types are intersexual. Certain plants with chromosome sets deviating from the normal were observed and the following formulæ suggested: 22 ($= 2X + 3Y + a' + 16a$) and 22 ($= 2X + 2Y + 3a' + 15a$). One tetraploid intersexual plant has been observed. It has the chromosome formula 29 ($= 3X + 2Y + 24a$). No a' chromosome was seen in its chromosome complement. J. L.

Cytology of Alnus rugosa.—Robert H. Woodworth ("Cytological Studies in the Betulaceæ. III. Parthenogenesis and Polyembryony in *Alnus rugosa*," *Bot. Gaz.*, 1930, **89**, 402–8). *Alnus rugosa* is highly polymorphic. Microsporogenesis is very irregular, and only about 2 p.c. of the resultant pollen morphologically perfect. No signs of pollen tubes have been detected on thousands of pistils examined. Pairing of chromosomes is very rare at macrosporogenesis, and reduction fails completely. The plant sets a large quantity of viable seed. From one to four embryo sacs may form in one ovule. Embryos arise by parthenogenesis from the diploid egg and by nucellar budding. They are also suspected of arising from the synergids, the antipodals, and the endosperm. Several embryos may mature in one embryo sac. Several embryos may mature in each of two embryo sacs in the same ovule. Two embryos from the same seed can both develop to normal seedlings. Polymorphism, irregular meiosis, parthenogenesis, apogamy, nucellar budding and polyembryony point to a hybrid origin. J. L.

Chromosomes in Betulaceæ.—Robert H. Woodworth ("Cytological Studies in the Betulaceæ. II. *Corylus* and *Alnus*," *Bot. Gaz.*, 1929, **88**, 383–99). There is no evidence of polyploidy in the genus *Corylus*, all species and hybrids having 14 haploid chromosomes. The genus is characterised by more or less normal meiosis, with the exception of occasional fusion of two or more pairs of chromosomes at diakinesis. Natural hybrids are easily formed, and show some meiotic irregularities, known to be due to heterozygosis. In *Alnus* the fundamental chromosome number is also 14. *A. glutinosa* and *A. japonica* are tetraploids with $n = 28$. *A. rugosa* shows marked hybrid cytological characters, and is considered heterozygous. Dysploidy may be due to unequal chromosome distribution, chromosome extrusion, or to cytomyxis and chromosome migration. J. L.

Cytoplasmic Structure in Gymnosperms.—ROBERT H. BOWEN and LOUISE H. BUCK ("Notes on Cytoplasmic Structure in Gymnosperms," *Ann. Bot.*, 1930, **44**, 565–86). Primary root-tips and young seedlings of four species of *Pinus* were examined. The same structural components are found in the cytoplasm as have been observed in representatives of the Bryophyta, Pteridophyta, and Angiospermæ. These components are: (1) plastidome, (2) pseudochondriome, (3) vacuome, (4) osmiophilic platelets, (5) oil-droplets. The morphology and behaviour of these various elements are described. It is found that they agree almost exactly with those of the elements in the other groups of plants. The osmiophilic platelets are described in gymnosperms for the first time. There is no evidence from meristematic tissues that any particular cytoplasmic body can be regarded as the homologue of the animal chrondriosome. J. L.

Microsporogenesis in Taxus.—LILIAN HAWKER ("Microsporogenesis in *Taxus*," *Ann. Bot.*, 1930, **44**, 535–9). *Taxus* differs from all other conifers for which microsporogenesis has been described in the behaviour of its chromosomes during metaphase. The haploid number of chromosomes is 8 and the diploid 16. In polar view of the metaphase plate the chromosomes appear as tetrads. The pollen mother-cells appear to be of two kinds, some with 16 small chromosome tetrads, and others with 8 large tetrads. In both types of cell the result of the reduction division is the same—i.e., 8 chromosomes arrive at each spindle pole. The second division takes place normally. J. L.

Chromosomes in Cucurbitaceæ. — SARA F. PASSMORE ("Microsporogenesis in the Cucurbitaceæ," *Bot. Gaz.*, 1930, **90**, 213–23). The following chromosome numbers are given for the members of the Cucurbitaceæ studied: *Cucurbita Pepo* and *C. maxima* n = 20, *Citrullus vulgaris* and *Luffa cylindrica* n = 11, *Cucumis Melo* n = 12, *C. sativus* 2n = 14. The details of microsporogenesis are described. In *Cucumis sativus* there is an irregular distribution of chromosomes on the spindle at anaphase. Nucleolar budding is observed in *Luffa cylindrica* and *Cucumis sativus*, and the nucleolus is often present after the spindle fibres appear in these species.

Chromosomes in Cucurbits.—T. W. WHITAKER ("Chromosome Numbers in Cultivated Cucurbits," *Amer. Journ. Bot.*, 1930, **17**, 1033–40). The following chromosome numbers have been determined in the material investigated: *Cucumis sativus* n = 7, *C. Anguria* n = 11, *C. Melo* n = 12, *Citrullus vulgaris* n = 11, *Lagenaria vulgaris* n = 11, *Cucurbita Pepo* n = 20, *C. maxima* n = 20, *C. moschata* n = 24. J. L.

Chromosomes in Juglandaceæ.—R. H. WOODWORTH ("Meiosis of Microsporogenesis in the Juglandaceæ," *Amer. Journ. Bot.*, 1930, **17**, 863–9). The haploid chromosome number is 16 in *Juglans regia*, *J. rupestris*, *J. nigra*, *J. cinerea*, *J. mandshurica* and *J. Sieboldiana* var. *cordiformis*. In all these species meiosis is regular. *J. notha* is a known hybrid with 16 haploid chromosomes, and displays meiotic irregularities. *Carya ovata*, *C. laciniosa*, and *C. cordiformis* have 16 haploid chromosomes and show regular meiosis. Meiosis is also normal in the tetraploid species *Carya alba*, *C. glabra* and *C. ovalis*, which have 32 haploid chromosomes. *Carya Laneyi* var. *chateaugayensis* (n = 16) is a known hybrid with the usual irregular meiotic divisions. *Pterocarya Rehderiana* (n = 16) is also a known hybrid, and shows meiotic irregularities. The Juglandaceæ with 16 chromosomes may be phylogenetically related to the 8-chromosome branch of the Betulaceæ. J. L.

Chromosomes in Betulaceæ.—R. H. Woodworth ("Cytological Studies on the Betulaceæ. IV. *Betula, Carpinus, Ostrya, Ostryopsis*," *Bot. Gaz.*, 1930, **90**, 108–15). *Betula lutea* is hexaploid, with 42 haploid chromosomes. *B. papyrifera* has 35 haploid chromosomes, while the following numbers are given for its varieties: var. *cordifolia* 28, var. *subcordata* 28, var. *kenaica* 35, var. *occidentalis* 42. *B. pumila* var. *glandulifera* has 28 haploid chromosomes. *B. purpurii* is a natural hybrid with $2n = 70$, and shows meiotic irregularities. *Carpinus, Ostrya,* and *Ostryopsis* species have 8 as the fundamental chromosome number. *Carpinus Betulus* var. *fastigiata* is octoploid, with 32 haploid chromosomes. From its meiotic behaviour *Carpinus cordata* is probably of hybrid origin. There are possibilities of its being a bigeneric hybrid between *Carpinus* and *Ostrya*. The results furnish evidence for the theory that multiplication of species has come about to a considerable extent by hybridization. J. L.

A Haploid Œnothera.—R. Ruggles Gates and K. M. Goodwin ("A New Haploid *Œnothera*, with Some Considerations on Haploidy in Plants and Animals," *Journ. Genetics*, 1930, **23**, 123–56). The hybrids produced from the cross *Œ. rubricalyx* × *Œ. eriensis* are non-viable, dying in a few days. Two seedlings in a family of 85 persisted, and one which survived to maturity was haploid. This new type was much dwarfed in all its parts, and completely sterile as regards pollen and seed production. The cells of the haploid are smaller than those of diploids. The ratio of decrease in cell size corresponds in general with that of increase in size in various tissues of the tetraploid. The various cases of haploid sporophytes in flowering plants—*Datura, Nicotiana, Triticum, Solanum, Brassica, Matthiola, Crepis* and *Œnothera*—and of animal species in which the males are haploid are reviewed. Although haploid plants can be reared to maturity, haploid animals usually either fail to reach maturity or double their chromosomes during development. Haploid plants have appeared, (*a*) after crossing, especially with a distantly related species; (*b*) after subjection to cold at the time of fertilization; and (*c*), in the tomato, "spontaneously." J. L.

Chromosomes of Wheat Hybrids.—J. A. Jenkins and W. P. Thompson ("Chromosome Conditions in the Second and Third Generations of Pentaploid Wheat Hybrids," *Canad. Journ. Research*, 1930, **2**, 162–70). The numbers and mating capabilities of the chromosomes were determined in a good many F_2 plants and their offspring in two crosses between common (42-chromosome) wheats and emmer (28-chromosome) types. In general the results confirmed those of Kihara and supported his conclusions. Chromosome numbers were much nearer those of the parental types than was to be expected if all germ cells were capable of functioning and all zygotes of developing. A large number of expected chromosome types did not appear at all. A high p.c. of F_2 had only 14 bivalent chromosomes and 0–7 univalents. These tended to revert rapidly to the 14-bivalent condition of emmers. F_3 in this group did not have more than 14 bivalents nor more univalents than their F_2 parents. A chromosome formula for all of the group of F_2 with more than 14 bivalents may be written $(14 + \times)$ bivalents $+$ $(7 - \times)$ univalents. These tended to revert to the 21-bivalent condition of common wheat. F_3 in this group did not have fewer bivalents nor more univalents than their F_2 parents. Occasional plants were exceptions to these rules. J. L.

Shrivelled Endosperm in Species Crosses in Wheat.—W. P. Thompson ("Shrivelled Endosperm in Species Crosses in Wheat, its Cytological Causes and Genetical Effects," *Genetics*, 1930, **15**, 99–113). In crosses between 14- and 21-chromosome wheats the F_1 grains are plump when the 21-chromosome species

is female, and wrinkled when it is male. When plump, the endosperm of the seed is diploid with respect to the extra 7 *vulgare* chromosomes, and when wrinkled haploid. In backcrosses of F_1 with *vulgare* the majority of seeds are plump when *vulgare* is female; in the reciprocal nearly all are shrivelled. In backcrosses with emmers also the seeds are better when the pure parent is female. Determinations were made of the chromosome numbers of many backcross plants produced by different kinds of seeds. The following correlations were made evident: the endosperm is plump when it contains (*a*) none or few of the extra 7 *vulgare* chromosomes, (*b*) three complete sets of 7, and (*c*) two complete sets of 7. It is shrivelled when it is (*a*) haploid for all or many of the 7, (*b*) diploid or triploid for some only. The farther the chromosome situation departs from the complete absence or complete diploidy or triploidy of the *vulgare* chromosomes, the severer is the shrivelling. The endosperm conditions play a large part in the non-appearance of many types in F_2 and later generations of ordinary crosses. J. L.

Chromosomes in Diœcious Plants.—Y. Sinotô ("Chromosome Studies in Some Diœcious Plants, with Special Reference to the Allosomes," *Cytologia*, 1929, **1**, 109–91). The male plants of 17 genera, 22 species, and 2 varieties of diœcious phanerogams have been cytologically studied. Thirteen forms each show an unequal pair of chromosomes in addition to autosome pairs at the meiotic division. These forms are species of *Salix, Morus, Cannabis, Datisca, Daphniphyllum, Trichosanthes, Hydrilla* and *Trachycarpus*. The unequal chromosome pair is assumed to be a sex chromosome complex of an X-Y type. There is no evidence of the existence of sex chromosomes in the male of *Spinacia oleracea*, nor in *Aucuba japonica*. In *Humulus japonicus* a tripartite chromosome is present at first meiotic division in addition to 7 autosomic gemini. The tripartite divides in such a way that two kinds of pollen grains may be formed. In *Humulus Lupulus* a tetrapartite chromosome is present, and may be a new type of sex chromosome complex. *Xanthoxylum piperitum* has 35 chromosomes at first metaphase. The behaviour of one of these suggests that it is a sex chromosome of the XO-type. A separate summary is given concerning the microsporogenesis of *Rumex acetosa*. No definite conclusion can be drawn as to whether the karyo-constitutional digamety of pollen grain is displayed in external character such as size. A list is given of the gametic chromosome numbers of all the plants investigated. J. L.

Chromosomes and Phylogeny in Viola.—J. Clausen ("Chromosome Number and Relationship of Some North American Species of *Viola*," *Ann. Bot.*, 1929, **43**, 741–64). The following chromosome numbers for species of *Viola* have been determined: *V. adunca* n = 10, *V. rupestris* var. *arenaria* 2n = 20, *V. striata* n = 10, *V. uliginosa* n = 10, *V. pedunculata* n = 6, *V. ocellata* n = 6, *V. pubescens* 2n = 12, *V. glabella* n = 12, *V. purpurea* 2n = 24 ?, *V. chrysantha* n = 12, *V. sarmentosa* n = 12, *V. Rafinesquii* n = 17, *V. nana* 2n = 48 ?, *V. rothomagensis* n = 17. A list of the 87 *Viola* species whose chromosome numbers are known is given. A reclassification of the violets of the northern hemisphere is attempted, based upon morphological studies and knowledge of chromosome numbers. The essential points of the reclassification are: (*a*) the *Nominium* section has been subdivided into *Rostellatæ* with a 10-series of chromosome numbers, and *Plagiostigma* with a 12-series; (*b*) the former *Dischidium* section has been included in the *Chamæmelanium* section. (*c*) The West American yellow violets, previously of the *Nominium* section, can very naturally be included in the *Chamæmelanium* section. The phylogeny is considered from the morphological, cytological, genetical and geographical aspects. The *Chamæmelanium* section is thought to be the primitive and central group. J. L.

Normal and Divergent Plastid Types in Zea.—C. Zirkle ("Development of Normal and Divergent Plastid Types in *Zea Mays*," *Bot. Gaz.*, 1929, **88**, 186–203). In the growing point of the root the plastid primordia are mitochondria. The whole development from primordium to mature plastid takes place within the range of a few contiguous cells. In the region of differentiation of the root there are two types of mitochondria, the larger of which develop into plastids and the smaller remain unchanged. The plastid primordia in the growing point of the stem are either mitochondria or minute plastids. The primordia in the epicotyl develop very quickly into plastids. There is some evidence that plastid-like bodies may fragment into mitochondria. The primordia of chloroplasts in embryonic leaves are minute plastids. In the mature leaf different cells have very different kinds of plastids. In all aberrant types investigated, the plastid primordia were normal so far as could be observed, the divergent types being due to (1) a delayed development, (2) a stoppage of the development, and (3) a stoppage of development followed by degeneration. J. L.

The Achromatic Figure in Fresh Material.—Walter Robyns ("La figure achromatique, sur matérial frais, dans les divisions somatiques der phanérogames," *La Cellule*, 1929, **39**). The formation of the achromatic figure has been studied in fresh material of *Hyacinthus*, *Vicia*, and *Allium* roots. The nucleus possesses a definite membrane, which at prophase is heterogeneous and formed by the chromosomes and, between them, fragments of the "Hautschicht," which are the limiting portions of the nuclear substance. Polar caps have been observed in the rootlets of *Hyacinthus*. These are perfectly hyaline and distinct from the cytoplasm. The spindle is entirely of nuclear origin, and at every stage of its evolution consists of a clear homogeneous area, slightly grey, without any discernible structure and surrounded on all sides by granular cytoplasm. At the death of the cell the nuclear area disappears without the appearance of any structure. On the other hand, a slight striation in the spindle body becomes visible on controlled fixation. Micro-dissection methods have shown that the spindle body is formed of a gel more dense than the cytoplasmic gel. The consistency of the spindle gel varies during the evolution of the achromatic figure. The connective figure (the area between the anaphase groups of chromosomes) is quite homogeneous. Spindle fibres, or lamellæ, are artifacts produced by fixation, dehydration, and embedding, and do not exist in the living cell. In living and fresh material the cell plate appears as a continuous undulating lamella, occupying the entire depth of the cytokinetic spindle and finally functioning as the middle lamella. The granular appearance of the cell plate in fixed preparations is an artifact. J. L.

Chromosomes and Divisions in the Antherozoidal Filaments of Chara.—H. Telezynski ("Garnitures des chromosomes et synchronisme des divisions dans les filaments d'anthérozoïdes chez certaines espèces du genre *Chara* Vaill.," *Acta Soc. Bot. Poloniæ*, 1929, **6**, 230–47). The Characeæ are haploid plants. *Chara fragilis* is an auto-polyploid species. Its chromosome complement consists of 12 pairs whose members correspond to one another in length and shape. The pairs can be divided into three groups distinguished by their size differences. The following numbers are given for the species studied: *C. fragilis* 24, *C. contraria* 28, *C. ceratophylla* 14, *C. jubata* more than 40, *Tolypellopsis stelligera* 14. In most cases all the cells of one antherozoidal filament undergo division simultaneously with complete synchronism of division stages. The cells of a filament may, however, be in different stages of division. They are then disposed in groups which show strict synchronism of division stages. J. L.

Spermatogenesis in Mercurialis. — MARJA SZTAJGERWALDOWNA (" Quelques détails de la cinèse de maturation chez *Mercurialis annua* ♂," *Acta Soc. Bot. Poloniæ*, 1929, **6**, 335–40. Polish with French summary). The pollen mother-cell nuclei of *Mercurialis annua* contain chromocentres corresponding in number to the diploid chromosomes, i.e., 16. The details of prophase are described. At diakinesis there are 8 gemini, amongst which a " micropair " can be distinguished. The members of this " micropair " can be seen at the centre of the chromosomal plate in both heterotypic and homotypic divisions. The chromosomal complement of the male gametes is expressed by the formula 7 + m. J. L.

Diploid and Tetraploid Gametes in Tulipa.—W. E. DE MOL (" Producing at Will of Fertile Diploid and Tetraploid Gametes in *Duc van Thol, Scarlet* (*Tulipa suaveolens* Roth)," *Vierteljahrsschrift Naturforschenden Gesellschaft, Zürich*, 1928, **73**, 73–97, English with German summary). According to external conditions under which tulip bulbs are grown, one can at will produce diploid and tetraploid pollen grains. Such gametes may originate already in Holland, owing to different methods of cultivation. It is suggested that such gamete formation may have caused the condition of polyploidy. Full details are given of the cytological methods employed in this study. The somatic chromosome number in *Scarlet Duc* is 24. Fertile pollen grains of three sizes are produced, the smallest containing 12 chromosomes, the medium-sized containing 24, and the largest containing 48 chromosomes. The diploid grains originate by failure of cell division after heterotypic division, and the tetraploid grains by a further splitting of all 24 chromosomes. There is a constant relation between the number of chromosomes and the surface of the nucleus, and also between the number of chromosomes and surface of the pollen grain. A method of isolation of the diploid and tetraploid pollen grains is described, and an account given of the pollination experiments undertaken. J. L.

Fertilization in Rice.—Y. NOGUCHI (" Zur Kenntniss der Befruchtung und Kornbildung bei den Reispflanzen," *Jap. Journ. Bot.*, 1929, 385–403). The pollen grain begins to germinate immediately it comes in contact with the stigma. Nine hours later the pollen tube tip ruptures near the egg cell and liberates two spiral-shaped sperm nuclei. Normal double fertilization occurs. The development of the embryo and free nuclear division in the endosperm are described. J. L.

Effect of Vital Stains on Mitosis.—W. A. BECKER (" Influence des colorants vitaux sur le caractère de la cinèse somatique," *Acta Soc. Bot. Poloniæ*, 1929, **6**, 214–29, Polish with French summary). Experiments have been performed to determine the effect of neutral red and methylene blue solutions of various concentrations on the mitotic divisions in root-tips. Technical difficulties were experienced with neutral red. Onion roots show abnormal divisions in solutions of methylene blue of definite given concentrations. These abnormalities are only apparent after the onset of metaphase, and consist of clumping of the chromosomes, their retarded passage to the poles, a " pseudo-amitosis " and formation of binucleate cells. J. L.

The Plastid during Sporogenesis in Polytrichum.—T. ELLIOT WEIER (" Notes on the Plastid and Other Cytoplasmic Bodies During Sporogenesis and Spermatogenesis in *Polytrichum commune*," *Proc. Nat. Acad. Sci.*, 1930, **16**, 536–43). The archesporial plastid comes from a transformation of the pre-archesporial plastid. It consists of two parts: a broad filament, the plastonema, and a thin flat pellicle, the plastosome. These may be clearly seen in living material. The division of this body takes place by a cleavage into two approximate halves. This

archesporial plastid is very similar in shape to the Golgi body of animal cells, and possibly has a somewhat similar function. In the spermatogenetic tissue there is present in each cell a body resembling the archesporial plastid. This undergoes much structural change during transformation of the androcyte into the sperm. It possibly plays some part in the formation of the tail. There is no evidence of a relationship between mitochondria and plastids. Osmiophilic platelets are frequently observed. J. L.

Merogony in Nicotiana.—R. E. CLAUSEN and W. E. LAMMERTS ("Interspecific Hybridization in *Nicotiana*. X. Haploid and Diploid Merogony," *Amer. Naturalist*, 1929, **63**, 279–82). Among 173 F_1 plants of *Nicotiana digluta* ♀ × *N. tabacum* ♂ a single haploid *tabacum* plant was obtained. This differed strikingly from normal F_1 plants in having small white flowers and other distinct morphological features. In morphology and cytology this plant was identical with other haploid *tabacum* plants. It is concluded that it represents a true case of haploid merogony. It is suggested that the occasional pure *sylvestris* plants obtained in backcrosses of F_1 *sylvestris* – *tabacum* ♀ × *sylvestris* ♂ may arise from diploid merogony. In neither of these cases is any influence of the maternal cytoplasm discernible.
J. L.

Cleistogamy in Viola.—GERTRUDE WEST ("Cleistogamy in *Viola Riviniana*, with Especial Reference to its Cytological Aspects," *Ann. Bot.*, 1930, **44**, 87–109). The morphological features of the chasmogamous, semicleistogamous, and cleistogamous flowers of *Viola Riviniana* are described. The haploid chromosome number of *V. Riviniana* is 20. The meiotic divisions in the pollen and megaspore mother-cells show many points of similarity. A normal 8-nucleate embryo sac is formed, the synergids having a well-developed filiform apparatus. The details of fertilization are recorded. J. L.

Cytology of Hybrids.—HANNAH C. AASE ("Cytology of *Triticum*, *Secale*, and *Ægilops* Hybrids, with Reference to Phylogeny," *Research Studies State Coll., Washington*, 1930, **2**, 1–60). A cytological account is given of the meiotic phases in the pollen mother-cells and embryo-sac mother-cells of F_1 hybrids and in some cases their parents. With some exceptions, the hybrids may be arbitrarily classified as diploids, haploids, and semi-haploids. The diploids show approximately complete chromosome conjugation. The haploids have no bivalent chromosomes, or only a small fluctuating number of open bivalents. In meiotic behaviour they are indistinguishable from parthenogenetic haploids. *T. durum* × *T. vulgare* with 14 bivalents and 7 univalents is typical of the semi-haploid class. In these disjunction of bivalents proceeds normally, while the reduction of univalents proceeds as in the haploids. Haploidy and semi-haploidy invariably lead to unbalanced chromosome complements in the gametes, and consequent greater or less sterility. Non-reduction of univalents brings about diploidy and its consequent homology of mates. The homologous mates tend to vary as they are passed on through the progeny. The non-reduction of univalents thus favours species stability, while the tendency on the part of the homologues to change favours species splitting. Hybridization combines or redistributes the changed homologues. J. L.

Anatomy and Morphology

The Corm and Contractile Roots of Brodiæa lactea.—F. H. SMITH ("The Corm and Contractile Roots of *Brodiæa lactea*," *Amer. Journ. Bot.*, 1930, **17**, 9, 916–27, 18 figs.). In this paper the author gives a brief historical review of the

literature dealing with the structure and functions of contractile roots. An account is then given of work carried out on the corms of *Brodiœa lactea* (Lindl.) Wats. in order to determine their structure and mode of development, with special reference to their contractile roots. New corms arise annually from the terminal buds of old corms, whereas offsets arise in the axils of foliage leaves or cataphylls, and vegetate for several years before producing flowers. The actual contraction is due to changes in the cortical cells due to growth and turgor, and the stele becomes greatly distorted in the process. Contractile roots are produced only on offsets and never on parent corms. Their functions are stated to be food absorption and lowering the offsets in the soil. C. R. M.

The Anatomy of the Composite Flower.—M. F. Koch ("Studies in the Anatomy and Morphology of the Composite Flower. I. The Corolla," *Amer. Journ. Bot.*, 1930, **17**, 9, 938–52, 2 pls., and fig.). This paper is the first of a series dealing with the anatomy of the Composite flower, the present account being confined to the corolla. The anatomy has been investigated both from the point of view of the gross venation and by means of sections. The venation of disc and ray flowers is first dealt with. The primitive type of polypetalous corolla from which the gamopetalous type is thought to have been derived was composed of petals having one central and two lateral veins. As the petals fused, there has been a reduction in the number of the veins and in their arrangement, giving rise in the ray flower to three main types of venation, on the basis of which the tribes that have ray flowers may be separated into three groups termed the "Aster," "Heliantheæ," and "Mutiseæ" types. The Aster type has typically four, and the Heliantheæ eight veins, although these numbers are sometimes exceeded. In the Mutiseæ the corolla consists of a strap-shaped lobe with two short lips which spread laterally. A fourth group includes those tribes having only tubular and perfect florets, and is known as the "Discoid" type. It is stated to be impossible to decide, from a study of the gross morphology of the different types of venation, the manner in which the types have been derived from one another. The venation of ray and disc florets respectively is next described. In *Aster lævis*, of which the anatomy is used as an example of that of the disc floret, five to ten strands given off from the floral stele furnish the vascular supply of the floret. Five bundles persist and are the fused laterals of the corolla. The venation of the ray corolla originates in the same manner. The ray corolla is regarded as being a modification of the disc corolla of which the venation has become abortive. C. R. M.

The Morphology of the Achene.—H. M. Chute ("The Morphology and Anatomy of the Achene," *Amer. Journ. Bot.*, 1930, **17**, 8, 703–23, 3 pls.). In this paper an account is given of an investigation of the anatomy of the achenes and follicles of numerous genera and species of the Rosaceæ and Ranunculaceæ. The main conclusion reached is that the achene has been derived from the follicle, the evidence of this being shown by cases in which the number of ovules has been reduced or in which it can be seen that the simple vascular system of the achene has been derived from the more complex system of the follicle by reduction. The single trace of the achene is regarded as being formed by the lateral fusion of the dorsal with the two lateral traces which are thought to have been present in the primitive carpel. Two additional dorso-lateral traces, which are branches arising from the base of the dorsal trace, are present in some of the larger carpels of *Ranunculus*. Amongst the Rosaceæ the reduction in the vascular system is not so great as in the Ranunculaceæ. The genus *Waldsteinia* is of especial interest, as in it there occur achenes provided with a vascular system typical of follicles. The

chief difference in the mode of reduction in the two families investigated is that whereas in the Rosaceæ it is the dorsal trace which is most reduced, in the Ranunculaceæ the greatest reduction is in the two ventral traces. The greatest reduction of all was noted in the genus *Ranunculus*, where the two ventral traces have completely disappeared and the dorsal had become somewhat shortened.

C. R. M.

Leaf Anatomy of the British Heaths.—H. M. Smith ("Leaf Anatomy of the British Heaths," *Trans. & Proc. Bot. Soc., Edin.*, 1930, **30**, 3, 198–205, 3 figs.). In this paper an attempt is made to determine the interrelationships and systematic position of *Erica Crawfordii*, *E. Tetralix*, *E. Mackayi*, *E. ciliaris*, *E. Praegeri*, and *E. Stuartii*, using the characters and anatomy of the leaves as a basis for comparison. The epidermis of *E. Mackayi* is quite distinctive from that of the other species, except *E. Praegeri* and *E. Stuartii*, which are hybrids, of which *E. Mackayi* is one of the parents. For this reason it is concluded that *E. Mackayi* is more distinct from *E. Tetralix* than has been previously thought. *E. Crawfordii* is concluded to be a double-flowered form of *E. Mackayi*, and *E. Praegeri* is thought to be of hybrid origin, possibly between *E. Mackayi* and *E. Tetralix*. C. R. M.

The Recognition of Some Agricultural Grasses.—J. H. Whyte ("The Recognition of Some Agricultural Grasses by their Vegetative Characters," *Trans. & Proc. Bot. Soc., Edin.*, 1930, **30**, 3, 206–8). This paper consists of a key by means of which a number of the commoner agricultural grasses may be identified by their vegetative characters when not in flower. C. R. M.

Development and Anatomy of Monocotylous Seedlings.—L. Boyd ("Development and Anatomy of Monocotylous Seedlings. 1. *Paris polyphylla*. 2. *Costus speciosus*," *Trans. & Proc. Bot. Soc., Edin.*, 1930, **30**, 3, 218–29, 5 figs.). A description of the germination and anatomy of the seedlings of *Paris polyphylla* and *Costus speciosus*. In *Paris polyphylla* photosynthesis is carried out solely by the cotyledon during the first year. The anatomy is simple. The manner in which a monopodial rhizome arises is described. The seedling of *Costus* is of great interest because it differs from the Zingiberoideæ, to which it is most nearly related. Moreover, it is characterized by the development of "a green spherical outgrowth from the upper surface of the cotyledon where it enters the seed," and "a ligule arising from the basal end of the cotyledon similar to that of the adult *Costus* leaf." No traces of primitive characters such as those occurring in the Zingiberoideæ were observed. C. R. M.

Wood Structure of Pistol-Butted Hemlock (Tsuga Mertensiana).—R. Kienholz ("The Wood Structure of a Pistol-Butted Mountain Hemlock," *Amer. Journ. Bot.*, 1930, **17**, 739–64, 11 figs., 6 tables). The author describes an investigation of the wood structure of a pistol-butted mountain hemlock (*Tsuga Mertensiana*) growing at 3,500 feet elevation in the Cascade Mountains of South Western Washington. Its structure is compared with a straight tree of the same species from the same locality. A review of the previous work on the subject is given. The material investigated was cut from sections of the pistol-butted tree at heights of 1½, 6½, 14½ feet from the ground, and from 2, 12, and 22 feet levels in the straight specimen. The features especially studied were the total width of the rings, the proportion of the ring occupied by summer wood, and the radial and tangential diameters of the tracheids and their lengths, the thickness of the cell wall, and the number of medullary rays per unit of tangent. All these features were compared on the uphill, downhill, and sidehill radii of the trees at the different

levels mentioned. All these criteria, with the exception of the number of medullary rays per unit of tangent, were found to vary in the different parts of the trees examined, but one of the most interesting features observed was the reversal of the value of many of the criteria in passing from the 1½ to 6½ feet level. Thus the percentage of summer wood is greater, the compression wood is better developed, and the radial diameter of both spring and summer wood tracheids is smaller along the downhill radius at the 1½ foot level, whereas the condition is reversed at the 6½ feet level. A summary of the conclusions reached is clearly and concisely expressed in the form of a series of radial graphs. C. R. M.

Cicatrization of Foliage Leaves.—R. B. Wylie ("Cicatrization of Foliage Leaves. I. Wound Responses of Certain Mesophytic Leaves," *Bot. Gaz.*, 1930, **90**, 3, 260–78, 14 figs.). An intensive study of the reaction to wounds shown by leaves of deciduous plants. A general review of the rather scanty literature on the subject is given. Initial experiments were made with a wide range of deciduous plants, but later on intensive studies were made on young and old leaves of *Vitis vulpina* and *Rhus glabra*, together with some observations on *Syringa vulgaris*. Wounds were made with scissors, early in the afternoon at midsummer, at right angles to the main veins. Material was collected on alternate hours during the first day, once daily for 10 days, and at 5-day intervals for about 30 days. After treatment with chromacetic acid, sections were cut having a uniform thickness of 12μ. The reaction to wounding shown by the leaves experimented with may be divided into two categories. The first of these, known as the "pseudocicatrice," consists in the death and shrinkage of certain of the cells adjoining the wound. Cell divisions then take place, and some of the cells which already existed become enlarged in the region adjoining the pseudocicatrice, and the walls show evidence of lignification. This development is known as the cicatrice. In *Vitis vulpina* the pseudocicatrice is obvious within an hour after wounding. Lignin develops in the pseudocicatrice within three or four days in the same way as in the cicatrice. In the cells underlying the pseudocicatrice divisions occur on the fourth day. Before this happens, some of the cells become enlarged and tend to give the cicatrice as a whole a convex outline. *Rhus glabra* differs from *Vitis* in having leaves showing marked xerophytic tendencies and a well-developed latex system. The latex, thickened upper epidermis, and elongated palisade cells introduce modifications in the nature of the pseudocicatrice. In the formation of the cicatrice, cell enlargement occurs on the third day and cell divisions begin on the fourth. The cicatrice is fully developed within about two weeks. In immature leaves the softer tissues and less specialized epidermis result in a ready formation of the pseudocicatrice. The cicatrice is more restricted and there is less cell enlargement. The paper ends with a discussion of the results obtained. C. R. M.

Anatomy of the Woods of the Meliaceæ.—D. A. Kribs ("Comparative Anatomy of the Woods of the Meliaceæ," *Amer. Journ. Bot.*, 1930, **17**, 724–38). A study based on 112 species, representing 36 genera. The chief anatomical characteristics of the family are as follows:—Vessels (commonly containing gum deposits) with simple perforations; intervascular pits mostly minute, but in some genera large; fibres thin to very thick-walled; septa present or absent; pits simple or bordered; rays variable from homogeneous to decidedly heterogeneous, from one to ten cells wide and up to 250 cells high; vessel-ray pits of the same type as the intervascular; crystals in the wood-parenchyma present or absent. The paper includes a natural key to the genera on the basis of morphological characters, a natural key to the genera on the basis of wood structure, and an artificial key on

the basis of wood structure. To a certain extent the writer has followed the three important systems of classification for the family, namely, those of Harms, De Candolle and Bentham and Hooker. The generic key based on gross morphological features conforms fairly closely to the key based on wood structure, at least with respect to the larger groups. The genera *Cedrela*, *Carapa* and *Xylocarpus* are transferred to the subfamily Swietenioideæ, and *Lovoa* is set aside by itself in the subfamily Lovoinoideæ. *Chloroxylon*, *Flindersia*, and *Ptæroxylon* are considered to possess closer affinities to the Rutaceæ than to the Meliaceæ. The writer has been unable to find a set of anatomical characters that will distinguish the family as a whole. The Swietenioideæ is the only subfamily in which the genera form a distinct homogeneous group in respect to anatomical and morphological characters, and it is considered that it should be raised to the rank of a family to be called the Swieteniaceæ. Definite distinctions between the genera on anatomical grounds are not always possible. For instance, when terminal parenchyma is found in *Khaya*, the woods of *Swietenia*, *Khaya*, and *Pseudocedrela* are indistinguishable except that *Khaya* and *Pseudocedrela* have broader rays and *Pseudocedrela* is aromatic when fresh. Doubts have been expressed as to whether *Toona* is a distinct genus. Since the structure of the wood of *Toona* and *Cedrela* is the same, the writer has included *Toona* with *Cedrela*. On the basis of wood structure, certain species of *Aphanamixis* which have been placed in the synonymy of *Amoora* are easily separable from those of *Amoora*. Species of the closely-allied genera *Azadirachta* and *Melia* can likewise be separated on anatomical grounds.

B. J. R.

Evolution of the Vessel Segment in Dicotyledons.—F. H. Frost ("Specialization in Secondary Xylem of Dicotyledons. II. Evolution of the End Wall of the Vessel Segment," *Bot. Gaz.*, 1930, **90**, 198–212, 16 figs.). The paper continues the discussion of the evolution of the vessel segment, and traces the further specialization of the primitive scalariform perforation. The scalariform perforation is correlated with primitive tracheidal characters, namely, small diameter, angular outline, and thin walls evenly thickened. Specialization is accompanied by a decrease in length. The primitive fully-bordered aperture of a scalariform perforation gradually loses its border as specialization proceeds. Specialization is accompanied by a decrease in the inclination of the end wall. Specialization of the pitting on the lateral walls proceeds more rapidly than that of the end perforation. B. J. R.

Morphology and Systematic Position of Pherosphæra.—W. T. Saxton ("Notes on Conifers. VII. *Pherosphæra Hookeriana* Archer," *Ann. Bot.*, 1930, **44**, 957–63, 8 figs.). Doubts have been cast on the systematic position accorded to *Pherosphæra* as a member of the Podocarpaceæ. Root-tubercles are known in every other genus of the family, and these are now recorded for the first time in material of *Pherosphæra Hookeriana* from Tasmania. Some of the better preserved nodules contain clear and unmistakable fungal hyphæ. The anatomy of the leaf and stem was also studied. The leading features of the wood are distinctly Podocarpean. It is concluded that the anatomy and the presence of root-nodules strongly support the view that *Pherosphæra* should remain in the Podocarpaceæ, but in consideration of certain peculiarities in its ovular development, the total absence of prothallial cells in the pollen grain, and the erect axillary ovule with no epimatium, the retention of Pilger's subfamily Pherosphæroidæ, to include *Pherosphæra* alone, seems to be justified. B. J. R.

Effect of Water Supply on Development.—A. F. Barss ("The Effect of Moisture Supply on Development of *Pyrus communis*," *Bot. Gaz.*, 1930, **90**, 151–76, 11 figs.). The investigation was carried out on 48 Bartlett pear trees which were planted out in pots and divided into four lots. Each lot received identical treatment except in the application of water. Lot L received sufficient water to ensure that there was seepage in the pans in which the pots were standing; the plants were thus assured of a continuous supply. Lot F received the same amount of water as lot L, but was watered twice as often and was given half the amount at each application. Lot M received half the amount given to lot L (or lot F). Lot S received the smallest amount of water possible to keep the plants alive. As regards the histological development of the tissues, no outstanding differences were observed between lot L and lot F. Accordingly lot L was selected for detailed study. Differences in development were not limited to the total or proportionate amount of the separate tissues, but applied to the individual cells as well. The heavily watered lot L showed in its cellular composition a decided increase in the size of almost all cells, cortex, fibre, phloem and xylem, the xylem vessels being much larger in the late wood in this lot than in the corresponding position in lots M or S. Lot M showed the greatest development of cortex, but in most other respects was intermediate between lot L and lot S. The scantily watered lot S had the smallest and fewest cells. The production of summer wood as compared with spring wood was most evident in lot M and least evident in lot L. Wood parenchyma was abundantly developed in lot L, but was absent from lot S.

B. J. R.

Root and Shoot in the Angiosperms.—Agnes Arber ("Root and Shoot in Angiosperms: a Study of Morphological Categories," *New Phyt.*, 1930, **29**, 5, 297–314, 2 figs.). This is an attempt to review the various theories which have been put forward concerning the nature of the morphological units which make up the plant body. In the earlier of these the leaf and stem were regarded as discrete morphological entities, but, largely as a result of her own observations, especially those on certain of the Gramineæ, the author concludes that this distinction is untenable. Since this is so, the "Pericaulom" theory is discarded. The phyton theory is dismissed on the grounds that its adoption necessitates great complications. Moreover, the theory is regarded as belonging to "that group of over-ingenious academic conceptions which are difficult to discuss because they bear so little relation to reality." The first part of the discussion is based on formal morphology, and leads to the conclusion that root and shoot are primary morphological entities. Later on the question is discussed from an evolutionary standpoint, when the same conclusion is reached. "Of the alternative theories offered, Lignier's idea of the differentiation of a primitive cauloid" is regarded as being most useful as a working hypothesis.

C. R. M.

Studies in the Physiology of Cambial Activity.—J. H. Priestley ("Studies in the Physiology of Cambial Activity. III. The Seasonal Activity of the Cambium," *New Phyt.*, 1930, **29**, 5, 316–54, 1 fig.). This is a review of known facts about the seasonal variation in cambial activity in Dicotyledons and Conifers. A great number of isolated observations have been brought together and an attempt made to draw up generalizations. In general, it is concluded that the rhythm of cambial activity depends mainly on fluctuations in internal factors, although modifications can be induced by external influences. In Dicotyledons, in mild European climates, cambial activity begins in the spring in association with buds, and extends downwards from these points throughout the branches and trunk.

The activation of the cambium in the spring is thought to depend on a change in the contents of the cambial cells from a granular "gel" to a semi-fluid "sol" condition, this change taking place as the water table rises in the tree. A certain amount of cell-division probably takes place in the roots throughout most of the year. In the Coniferæ cambial activity likewise seems to develop downwards from the buds, although there is some evidence that cambial activity may also start independently in the trunk. Extension growth ceases before radial growth. In Dicotyledons the amount of spring wood does not vary very greatly, whereas the amount of summer wood produced varies according to the vigour with which the tree grows. In Conifers, on the other hand, vigorous growth is associated with a more abundant production of spring wood, so that the wood of conifers grown under unfavourable conditions is tougher than that produced in those growing under ideal conditions. Towards the end of the growing season a water deficit develops in the plant. When this happens, the intercellular spaces become filled with air, and starch accumulates in the wood. Cambial activity is thought to cease from above downwards when the water in the large intercellular spaces of the rays is displaced by air when the water deficit is set up, the converse also being true that activity is renewed when air is again displaced as the water table rises in the spring. In the conifers the intercellular spaces of the ray cells are smaller, and in these plants it is possible that cambial activity is less dependent on the water supply.

C. R. M.

Cambial Activity in the Red Raspberry Cane.—W. G. Brierley ("Cambial Activity in the Red Raspberry Cane in the Second Season," *Proc. Amer. Soc. Hort. Sci.*, 1929, 278–80). In this paper the results of observations on the behaviour of the cambium in the raspberry in the second year are described. In general the observations agree with those expressed in the more comprehensive review by Priestley (see last abstract). No activity occurs in the cambium until active growth begins in the lateral buds, and, indeed, it is stated that a considerable stimulus from the growing laterals is needed in order to cause the cambium to become active. The formation of new cambium begins immediately below the insertion of a bud and proceeds downwards. There was some evidence that phloem formation begins before xylem formation at the centre and tip regions of the canes. At the base and tip regions of the cane the phloem becomes brown and degenerates. This may contribute to the death of the old cane, although the formation of tyloses may play an equally important part in this connection. C. R. M.

CRYPTOGAMS.

Pteridophyta.

Abnormal Cones of Equisetum.—Shiv Ram Kashyap ("Some Abnormal Cones in *Equisetum debile*," *Journ. Ind. Bot. Soc.*, 1930, **9**, 240–1, 1 pl.). A description and figures of three abnormal cones of *Equisetum debile*, collected near Lahore. In each instance the cone is interrupted by the insertion of two leaf sheaths. A. G.

Fiji Ferns.—C. H. Wright ("Ferns Collected in Fiji by Sir Evera d im Thurn, K.C.M.G.," *Kew Bull.*, 1930, 343–8). A list of 59 species of ferns collected by Sir Everard im Thurn in Fiji during his governorship of the islands. The dates of collecting indicate the time of spore-maturity. A. G.

Roraima Ferns.—Albert C. Smith ("Notes on Pteridophyta from Mount Roraima," *Bull. Torrey Bot. Club*, 1930, **57**, 171–80, 1 pl.). Some ferns of exceptional interest collected by G. H. H. Tate on Mount Roraima, British Columbia,

are here discussed—*Hymenophyllopsis dejecta*, *Pterozonium cyclophyllum*, *Syngramma elaphoglossoides*, *S. brevifrons* (a new species), *Polypodium mollissimum*, *Cochlidium Connellii*, *Lycopodium Tatei* (a new species). A. G.

Bryophyta.

Spermatogenesis of Hepatics.—G. Chalaud ("Les derniers Stades de la Spermatogénèse chez les Hépatiques," *Ann. Bryol.*, 1930, **3**, 41–50, 4 figs.). In describing the final stages of spermatogenesis in typical species of *Sphærocarpus*, *Cephalozia*, and *Lophocolea*, the author points out that the spermatozoids are discharged from the apex of the antheridium, and become dispersed in the water slowly. Rotating round their axis, they advance with the help of their cilia, one of which probably is a motor and the other a rudder. The protoplasm of spermatids is vacuolar, and in it is often to be seen an oil globule analogous to those in the gametophyte. The size of the spermatozoid varies according to the genus, e.g., it is 15μ long in *Sphærocarpus*, 144μ in *Pellia Neesiana*. But the length is not constant; in a given species it varies within rather narrow limits. The cilia are not inserted at the same point: the anterior one is subterminal, the posterior one further back. Sometimes they are longer than the main body, sometimes shorter. They are of unequal length, the anterior usually being shorter, and they vary slightly in length in the same species. A. G.

Sphærocarpus.—Ch. Douin ("Le Thalle mixte du *Sphærocarpus*," *Ann. Bryol.*, 1930, **3**, 71–82, 1 pl.). The thallus of *Sphærocarpus* consists of a sort of flattened forking midrib and of lobes corresponding to the leaves of other hepatics; but the midribs and its forks have a terminal development, while the lateral lobes have a basal development. Between these lobes intermediate lobes develop; but midribs and lobes all grow soldered together; the lobes by being inserted longitudinally differ from the leaves of other hepatics. If the gametophyte of *Sphærocarpus* is morphologically a thallus, it can yet be regarded as a leafy stem in view of its manner of development, which is mixed. *Sphærocarpus* and *Riella* are the only thalli which have lobes continuing to the apex of the axis. Probably also *Blasia*, *Schistostega*, and *Aneura* are mixed thalli with lateral lobes inserted longitudinally. A. G.

Blasia and Nostoc.—A. J. M. Garjeanne ("Das Zusammenleben von *Blasia* mit *Nostoc*," *Ann. Bryol.*, 1930, **3**, 97–109, 2 figs.). A discussion of the relation of of host and epiphyte in the case of the infection of the leaf-auricles of *Blasia* by *Nostoc*. He concludes that the association of *Nostoc* with *Blasia* is of no great importance to either, (1) because he finds that there is no difference in growth and in nitrogenous contents, whether the *Blasia* plants be infected or non-infected; (2) because of the very poor development of infected *Blasia* plants growing on soil which is void of nitrates; (3) because of the occurrence of leaf-auricle domatia infected with quite other organisms, and yet so similar in structure and habit to *Nostoc* domatia as to be recognizable only by a yellowish colour; (4) because of the absence of cells or tissues, specially rich in nitrogen, in or near the domatia. For the *Nostoc* the sole advantage is the sheltered life which it enjoys in the auricle. A. G.

Reboulia.—Sister Mary Ellen O'Hanlon ("Gametophyte Development in *Reboulia hemisphærica*," *Amer. Journ. Bot.*, 1930, **17**, 765–9, 1 pl., 1 fig.). The manner of germination of the spores of *Reboulia* has not been described hitherto. The author tells us that the number of capsules on a head is 1–5, and the number of spores in a capsule is about 2,500. The spores are 70–80μ in diameter, and

they retain vitality for over five months. The spores germinate in about five days, requiring fairly good light and much moisture. In germination there first appear a germ tube and a single rhizoid. From the tip of the germ tube two cells (sometimes three) are cut off by transverse septation. The terminal cell then undergoes two divisions at right angles to each other, thus forming a primordium of four cells. From the two outer faces of this primordial group a periphery of cells becomes cut off. By differential growth at the apex of the germ tube a notch becomes formed in the marginal row of cells at the growing point, and to the activity of the meristematic cells in this marginal row the subsequent development of the thallus is due. Rhizoids develop beneath and ensure the dorsiventrality of the thallus. Weak illumination during germination induces abnormally long germ tubes. The young thallus invariably arises from a germ tube. A. G.

Symphyogyna.—ALEXANDER W. EVANS (" A Further Study of the American Species of *Symphyogyna*," *Trans. Connecticut Acad. Art Sci.*, 1927, **28**, 295–354, 1 pl., 12 figs.). An account of the American species of *Symphyogyna* which belong to the sections Integerrimæ and Dentatæ, with introduction, key to the species, and descriptions, figures and detailed notes on 10 species, two of which are new to science, *S. Lindmanii* and *S. fuscovirens*. A supplementary note on the species of the section Lobatæ is added. A. G.

Stephaniella.—TH. HERZOG (" Besitzt *Stephaniella*] ein Perianth ?" *Ann. Bryol.*, 1930, **3**, 110–14, 2 figs.). A discussion of the question whether the Andine genus *Stephaniella* possesses a perianth. On the evidence afforded by *S. hamata*, Stephani concluded that there is no perianth, but in its place is a mass of paraphyllia which effectively protect the young sporogonium. But the author has now obtained material of *S. paraphyllina* from Colombia, and is able to describe and figure the plant habit, involucral leaves, multiplicate perianth, paraphyllia, and archegonium of this species. A. G.

Mnioloma.—TH. HERZOG (" *Mnioloma* Herzog, nov. gen. Hepaticarum," *Ann. Bryol.*, 1930, **3**, 115–20, 4 figs.). Description of *Mnioloma*, a new genus of hepatics collected in Costa Rica by P. C. Standley. It bears no female inflorescence, but the structure of the leaves is so peculiar that the genus cannot be confounded with any other. The leaves and amphigastria have a well-defined border comparable with that found in the moss *Mnium*, as well as hexagonal cells rather mnioid in appearance. These are described and figured, as also are the perigonial bracts and antheridia. A. G.

Lejeunea in Chile.—ALEXANDER W. EVANS (" Two Species of *Lejeunea* from Chile," *Ann. Bryol.*, 1930, **3**, 83–8, 2 figs.). Descriptions and figures of *Lejeunea patagonica* Steph. and *L. corralensis*, a new species. Some critical remarks on the former species are made. The only other species that has been recorded from Chile is *L. globosiflora* Steph. A. G.

Drepanolejeunea.—TH. HERZOG (" Studien über *Drepanolejeunea*," *Ann. Bryol.*, 1930, **3**, 126–49, 21 figs.). The author discusses the genus *Drepanolejeunea*, first considering the characters by which it may best be distinguished from *Leptolejeunea*. The section Serrulatæ he divides into two groups—(1) Setistipæ, containing forms with typically very divergent crura on the amphigastria ; this group includes *D. Thwaitesiana* (Mitt.), *D. lævicornua*, *D. spinoso-cornuta*. (2) Latistipæ, with broader less-spreading amphigastrial segments ; here belong *D. Blumei*, *D. densistipula*, and *D. Bakeri*, the latter being described for the first time.

A. G.

Yunnan Hepatics.—W. E. NICHOLSON ("Atlantic Hepatics in Yunnan," *Ann. Bryol.*, 1930, **3**, 151–3). The author calls attention to the presence of a number of Atlantic species among the hepatics gathered by Handel-Mazzetti on the mountains of Yunnan. They are well known to hepaticologists as growing near the Atlantic coasts of Europe. The Yunnan representatives differ but slightly from the European. The majority of them lack sexual organs and gemmæ. They appear to be relics of an ancient flora, in view of their sterility, and they also possess remarkably incrassate cells, a xerophytic adaptation usually restricted to the Tropics. The species referred to are *Anastrophyllum Donianum*, *Anastrepta orcadensis*, *Jamesoniella Carringtoni*, *Lepidozia pinnata*, *Mastigophora Woodsii*, *Scapania nimbosa* and *S. planifolia*. Also *Frullania Jackii*, sterile in Europe, bears perianths and capsules in Yunnan. It is probable that Yunnan is nearer to the original home of these species than is Europe. A. G.

Moss-Culture.—W. LEACH ("Note on the Effect of Growing Mosses in a Moisture-saturated Atmosphere, and under Conditions of Darkness," *New Phyt.*, 1930, **29**, 276–84, 3 figs.). The modifications in the structure of certain common mosses, when grown in darkness and in a moist environment, are described. Leaves on shoots produced in darkness are much reduced in size—more so in acrocarpous than in pleurocarpous mosses. Differentiation of leaf cells is inhibited. Leaves tend to be reduced to a simple uniform type. The length of internodes is increased. The ability to grow in darkness varies widely with different species. In stems the number of cells and their diameter are reduced, and in the stems of different species of a single genus there is a tendency to produce cortical cells of a standard length. A. G.

Vegetative Reproduction of Mosses.—T. C. N. SINGH ("Notes on Vegetative Reproduction in Two Mosses from Mussoorie," *New Phyt.*, 1930, **29**, 355–60, 9 figs.). In the western Himalaya the bryophytes exhibit a tendency towards vegetative reproduction at the expense of fructification. Two examples of this are here described. In *Philonotis Turneriana* leafy bulbils occur usually in the axils of leaves round the growing apex on the stem. In *Bryum hemisphæricarpum* a number of multicellular club-shaped gemmæ are formed on a cushion-shaped receptacle situated in the axils of the leaves. The gemmæ are formed on the receptacle in acropetal succession. A. G.

Sperms of Sphagnum.—ANTON MÜHLDORF ("Über die Gestalt und den Bau der Spermien von *Sphagnum*," *Beihefte zum Bot. Centralbl.*, 1930, **47**, Erste Abteil., 169–91, 1 pl.). A detailed account of the shape and structure of the spermatozoids of *Sphagnum* in the mature state. The body of the spermatozoid is a sinistrorse spiral with two flattish turns, and is knoblike in front, gradually tapering to the other end. It bears two cilia, each exceeding it in length. These are the organs of locomotion, and one of them is borne close to the blunt apex of the body, the other being placed a little further back; the first tends to give a propulsion, the second a rotation. The nuclear and the plasma portions of the body are also described in detail, and very highly magnified figures are given. A. G.

Pilosium.—TH. HERZOG ("Ueber den Blattdimorphismus von *Pilosium* C.M.," *Ann. Bot.*, 1930, **3**, 121–5, 2 figs.). A description of the peculiarity of the lateral leaves of *Pilosium*, which possess a large and well-marked auricle on one side of the base, while the dorsal leaves are entirely without auricles, and the intermediate leaves have a mere trace of an auricle. These differences are made manifest in the figures. A. G.

Hungarian Bryophytes.—A. Latzel ("Moose aus dem Komitate Vas u. einigen anderen Komitaten," *Magyar Botanikai Lapok*, 1930, **29**, 105–35). An enumeration of the bryophytes collected by the late Major Wilhelm Piers and the author in the counties of Vas, Sopron, etc., in Hungary, preceded by a description of the physical geography of the district and its influence on the distribution of the species. The list comprises 48 species of hepatics, 9 sphagnales, over 220 mosses, with numerous varieties and forms. Some 90 p.c. are new records for the district, and several are additions to the flora of Hungary. Some of the forms are new to science. A. G.

Polish Mosses.—T. Wiśniewski ("Les associations des Muscinées (Bryophyta) épiphytes de la Pologne, en particulier celles de la forêt vierge de *Bialowieża*," *Bull. Acad. Polonaise Sci. Lett.*, ser. B., **1** (1929), Cracovie, 1930, 293–342, 10 pls., 11 tables, 4 figs.). In his introduction the author gives an account of the primitive forest of Bialowieża in Poland, and describes his methods of studying the associations of epiphytic bryophyta. The associations discussed are as follows:—(1) *Anomodon viticulosus* and *Leucodon sciuroides*, (2) *Drepanium cupressiforme* var. *filiforme* and *Orthodicranum montanum*, (3) *Eurhynchium striatum*, (4) *Pleurozium Schreberi*. Tables of the species comprised in each of these, their habitats and distribution, are given. The ecological factors—light, temperature, humidity—are considered. Further chapters treat of biological adaptations, ecological distribution, and geographical distribution of these epiphytic bryophytes. A. G.

Thallophyta.

Algæ.

Reproduction of Diatoms.—Lothar Geitlar ("Differenciation, répartition et détermination du sexe chez les diatomées pennées," *Arch. de Bot.*, 1929, **3**, 105–12, 1 pl., 2 figs.). A discussion of the processes of reproduction observed in the Pennatæ group of the diatoms, with the differentiation, distribution, and determination of sex. He submits a tentative scheme of classification based on whether the sexual state is determined during the diplophase or during the haplophase. A. G.

Pithophora.—K. Mothes ("Morphologische und physiologische Studien an der Cladophoracee *Pithophora*," *Ber. d. Deutsch. Bot. Gesellsch.*, 1930, **48**, (110)–(121), 1 pl.). A study of the morphology of *Pithophora* and of the behaviour of the filament and of its resting cells under experiment, in relation to salinity, drought, and illumination. A. G.

Cytology of Œdogonium.—Hiro Ohashi ("Cytological Study of *Œdogonium*," *Bot. Gaz.*, 1930, **90**, 177–97, 3 pls., 21 figs.). The cytology of *Œdogonium* has been little studied hitherto. The author found in *Œ. grande* the best material for revealing the mitotic process. The number of chromosomes is 13 in that species. Spermatogenesis is traced out for both antheridia and sperms, and in the mitosis of the antheridial cell an unusual condition in cell division is described. The spermatogenesis of the dwarf male was best seen in *Œ. nebraskense*. In the oogenesis of *Œ. nebraskense* there is a suffultory cell, but in *Œ. americanum* there is none; the nucleus in oogenesis behaves differently from that observed in vegetative cell division. As soon as fertilization has taken place in *Œ. americanum*, the spore coat develops on the egg and consists of three layers. In zoospore formation the behaviour of the nucleus was found to be different from that described by Strasburger for *Œ. tumidulum*. Change of temperature is an important factor in the formation of zoospores. A. G.

Halimeda.—ERMINIO MIGLIORATO ("Notizie su di un autotipo di '*Halymeda Lessoni*' Bory et Chauv.," *Arch. Bot.*, 1930, **6**, 317–18, 1 fig.). A photograph of an alga from Iles Célébes referred to *Halimeda Lessonii* Bory in the handwriting of Chauvin. A brief description of the external appearance of the plant is supplied; no indication is given of the internal structure. The type of *H. Lessonii* from Borabora, Society Islands, was found to be identical with *H. Tuna* in its structure; confer E. S. Barton:—The genus *Halimeda* (Siboga Exped. Monogr. 60, p. 14 (1901).
A. G.

Reproduction of Caulerpa.—TH. ARWIDSSON ("Beiträge zur Kenntniss der Fortpflanzungsorgane der *Caulerpa*," *Svensk Bot. Tidsk.*, 1930, **24**, 2, 263–79, 5 figs.). Dostál's discovery of the reproductive organs of *Caulerpa prolifera* in the Mediterranean in 1927 has suggested the desirability of searching the pickled material of species of *Caulerpa* collected by Prof. N. Svedelius in Ceylon in 1903. Specimens of *C. scalpelliformis* were found among them which contained masses of swarm-spores, also the papillæ from which discharge takes place. These and the protoplasm-balls in *C. dichotoma* are described and figured, and all that is now known of the process of reproduction of *Caulerpa* is discussed. A. G.

Lithodermeæ.—NILS SVEDELIUS ("Über die sogenannten Süsswasser-Lithodermen," *Zeitschr. für Bot.*, 1930, **23**, 892–918, 13 fig.). In 1875 Areschoug described *Lithoderma*, a genus of Phæophyceæ, with a marine species, *L. fatiscens*, and a freshwater species, *L. fluviatile.* To these was added the freshwater *L. fontanum* by Flahault in 1883. In 1893 Gomont described the genus *Heribaudiella* with a freshwater species *H. arvernensis*. Having carefully investigated the structure of the plants, Svedelius accepts *Heribaudiella* for the freshwater forms, and shows that these belong to one and the same species, which must be styled *H. fluviatilis*. A. G.

Bangiales.—HARALD KYLIN ("Some Physiological Remarks on the Relationship of the Bangiales," *Bot. Not.*, 1930, 417–20.) A discussion of the systematic position of the Bangiales. The Bangiaceæ differ anatomically from the Florideæ in having no pit-connections between the cells. In the sexual organs the Florideæ have terminal spermatangia, each producing a single spermatium, while in Bangiaceæ the spermatangia are intercalary and produce many spermatia; in Florideæ the carpogonia, each with a long trichogyne, are terminal on special branches, while in Bangiaceæ the carpogonia are intercalary and have no trichogyne. However, it should be remembered that the spermatia in both these groups are immobile, as also are the carpospores. The main reason for referring the Bangiaceæ to the Rhodophyceæ has been the red colour due to phycoerythrin. The author's conclusion is that the Rhodophyceæ have descended from the Cyanophyceæ and contain two very distinct groups, namely, Bangiales and Florideæ. The Bangiales branched off early and developed in their own special way. He does not admit that *Prasiola* can belong to the Rhodophyceæ. A. G.

Nucleus in Callithamnion.—M. A. WESTBROOK ("The Structure of the Nucleus in *Callithamnion* spp.," *Ann. Bot.*, 1930, **44**, 1012–15, 1 fig.). An investigation of the structure of the nucleus in some species of *Callithamnion* and allied genera of Ceramiaceæ. An account is given of the methods adopted and the staining reagents used. The nuclear structure in cells of antheridial groups in *C. tetricum* and *C. brachiatum* is described and figured, as seen in the various stages of cell division. The disturbing effect caused by some fixing agents is pointed out. The work was undertaken to test the results reached by W. T. Mathias in his paper

on "The Cytology of *Callithamnion brachiatum*" (*Pub. Hartley Bot. Lab.*, 1928, **5**, 1–27), and the present investigation shows the resting nucleus and somatic divisions in *Callithamnion* to be far more normal than would appear from the earlier paper. A. G.

Compsothamnion.—M. A. WESTBROOK ("*Compsothamnion thuyoides* (Smith) Schmitz," *Journ. Bot.*, 1930, **68**, 353–64, 2 pls.). An account of *Compsothamnion thuyoides* founded on material gathered at Plymouth. The habit and cytology are described, as also are the characters of the male plants, female plants, and asexual. Records are given of the occurrence of polysporangia, and of the periodicity of reproduction. The systematic position of the genus is discussed, and a bibliography is appended. A. G.

Ceramium in Baltic.—G. EINAR DU RIETZ ("Studies in the Taxonomy and Ecology of *Ceramium diaphanum* in the Baltic," *Bot. Not.*, 1930, 433–58). The author discusses the taxonomy of *Ceramium diaphanum* and the ecology of this species in the Baltic. In summing up his experiences of the seasonal alternation of generations in *C. diaphanum* at Jungfrun Island, he states that tetraspores are common from the end of May to early in September, and paraspores are commonly found from the beginning of June till the middle of August. Round parasporangia as described by Rosenvinge for the Danish waters have been noted only once. Cystocarps are common in August. Antheridia have been noted by others elsewhere. The overwintering generation of *C. diaphanum* is tetrasporic, and is confined to the *Fucus-Pylaiella* belt and the *Furcellaria* belt. Its spores give rise to a second tetrasporic generation found in the late spring and early summer in the lower and middle parts of the summer-annual belt and below it. From this second generation of tetraspores arises the sexual generation of late summer, which occurs partly as a narrow horizon at a higher water-level, and partly epiphytic on *Dictyosiphon* and *Fucus* at a lower level. Finally, the author gives a *résumé* of what is known of the life-history of *C. diaphanum*. A. G.

Reproduction of Ahnfeltia.—E. CHEMIN ("*Ahnfeltia plicata* Fries et son mode de reproduction," *Bull. Soc. Bot. France*, 1930, **77**, 342–54, 1 pl., 7 figs.). An account of *Ahnfeltia* and of the reproductive bodies on its branches, which have been regarded by various authors as a parasitic genus *Sterrocolax*. The nemathecia are described, and the development of the monospores in cultivation. After a study of the species of *Ahnfeltia* preserved in herbaria, he finds that the genus is reduced to a single species, *A. plicata*, with two varieties, var. *setacea* and var. *elongata*. Its remarkable coriaceous consistency is due to its peculiar structure, and its nemathecia produce monospores. Its taxonomic position is uncertain in the absence of sexual organs; but it shows affinity with *Gymnogongrus*, and its convenient place is in the tribe Tylocarpeæ of the family Gigartinaceæ. A. G.

Algal Zones.—G. EINAR DU RIETZ ("Algbälten och Vattenståndsväxlingar vid Svenska Östersjökusten," *Bot. Notis.*, 1930, 421–32). The author recalls his discovery of the existence of belts or zones of algæ on the Baltic coasts of Sweden, due to changes of water-level, and especially sharply marked by the low-water line of springtime. The following maritime and marine vegetation belts are recognized on the east coast of Sweden:—(I) Aërohalophyte belt; (II) Hygrohalophyte belt, the lower limit being marked by *Verrucaria maura*; (III) Hydrohalophyte belt, comprising (1) the belt of summer-annual filiform algæ, the lower limit being determined by the low-water periods in spring; (2) the *Fucus-Pylaiella* belt; (3) the *Furcellaria* belt; (IV) Belt of pure zoocoenoses. A. G.

Swedish Algæ.—O. Borge ("Beiträge zur Algenflora von Schweden. 4. Die Algenflora am Grövelsee," *Arkiv. för Bot.*, 1930, **23**A, no. 2, 1–64, 2 pls., 9 figs.). An account of the algæ in the alpine lake Grövel, in the far north of Dalarne, lying at about 2,700 feet altitude. The enumeration contains 108 genera with nearly 500 species and numerous varieties. Nearly 30 of these are new records for the Swedish flora. A. G.

Baltic Algæ.—G. Einar Du Rietz ("Three Species of Marine Algæ New for the Swedish Part of the Baltic," *Bot. Notis.*, 1930, 360–7). A discussion of three brown algæ—*Desmotrichum balticum* Kütz., *Leathesia difformis* (L.) Aresch., *Scytosiphon lomentarius* (Lyngb.) J. Ag.—never collected previously from the Swedish part of the Baltic. A complete algal flora of this area is in preparation. A. G.

Suez Canal Algæ.—Lilian Lyle ("Algæ of the Suez Canal," *Journ. Bot.*, 1930, **68**, 327–33). A list of the algæ collected by the Cambridge University expedition in the Suez Canal and Bitter Lakes in 1924, together with extracts from Prof. Munro Fox's report published in 1926, descriptive of the waters, tides, currents and other factors concerned in the distribution of species. The systematic list contains 3 phanerogams, 1 species of Myxophyceæ, 11 Chlorophyceæ, 7 Phæophyceæ, 19 Florideæ. It appears that only two Mediterranean algæ have penetrated into the Canal, whereas 13 species have migrated into the Canal from the Red Sea. Algæ are rare on the containing banks of the Canal, save on rock ledges, but are more abundant on timberwork, buoys and barges. A. G.

Vacuome of Characeæ.—M. Cazalas ("Sur l'evolution du vacuome des *Chara* et *Nitella* dans ses relations avec les mouvements cytoplasmiques," *Le Botaniste*, 1930, **22**, 296–322, 3 pls.). A discussion of the evolution of the vacuome in relation to the cytoplasmic movements in the Characeæ. In very young cells the protoplasmic currents are very small and local, and do not move the vacuoles. Gradually the protoplasm develops more activity and becomes more viscous. In the initial cell the plastidome is situated at the periphery; it contains carotin pigment; in older cells the fine protoplasmic network becomes evident with the plasts in the meshes. The evolution of the vacuome shows three stages:—(1) the young vacuome formed of small vacuoles concentrated; (2) the adult vacuome presenting phenomena of fragmentation and aggregation; (3) the older vacuome with viscous contents. Where the protoplasm is in contact with the vacuome there seems to be a periodical miscibility of the protoplasm in the vacuolar liquid. A. G.

Fungi.

Study of Chytridiales.—J. S. Karling ("Studies in the Chytridiales. IV. A Further Study of *Diplophlyctis intestina* (Schenk) Schroeter," *Amer. Journ. Bot.*, 1930, **17**, 771–8, 4 pls., 2 text-figs.). This paper is a revision and continuation of previous work on *Diplophlyctis*. The fungus grows in the cells of Characeæ, and the thickness of the host-walls renders observation difficult. The escape and germination of the zoospores, however, are described, and more especially the stages of germination, with the development of the apophysis and the rhizoids, the rhizoidal system being of unusual importance in the classification of the Chytridiales. Karling differentiates rhizoids from ordinary mycelia in that rhizoids tend to decrease in diameter and taper to a fine point; they do not in this fungus show a tendency to form new growth centres, whereas true mycelia give rise to new growths of sporangia and zygospores. A. L. S.

New Sclerospora.—WILLIAM H. WESTON, JR. ("A New *Sclerospora* from Australia," *Phytopathology*, 1930, **19**, 1107–15, 1 text-fig.). The fungus was found at Glen Innes, New South Wales. Clumps of *Sorghum plumosum* showed a fraying of the leaves into tangled fibres, similar to the effect produced by *Sclerospora graminicola* on *Setariæ*. Only the resting spore stage of the fungus was found. The oospores were in abundance, and differed sufficiently from those of other *Sclerosporæ* to justify the new species, *S. noblei*. As the host is endemic to Australia, it is suggested that the fungus may also be endemic. A. L. S.

Note on Sclerospora.—J. H. MITTER ("A Note on *Sclerospora graminicola* (Sacc.) Schroet. in Allahabad," *Journ. Ind. Bot. Soc.*, 1930, **9**, 243). The author points out that *Sclerospora graminicola* on *Pennisetum typhoideum* is known to grow sporadically, but that experience proves that it is most abundant in low-lying lands, particularly ill-drained land. The plants may be so diseased that no grain at all is produced. A. L. S.

Ascoidea rubescens.—LEVA B. WALKER ("Studies on *Ascoidea rubescens*. I. History and Development," *Mycologia*, 1931, **23**, 51–76, 5 text-figs.). The fungus here described has been known in Europe for a considerable time; it lives on slime flux of various trees, and has recently been discovered in America. Workers have differed as to the relationship, but the present author evidently inclines to the Phycomycetous relationship of the fungus. She was able to follow in cultures the formation of sporangia and conidia. The former she secured in hanging water drops; she found that they developed only on hyphæ near the surface of water, and that alternate drying and wetting were favourable conditions. Conidia developed in the air or, if on submerged hyphæ, near the surface. Both conidia and sporangiospores give rise to conidia or to hyphæ according to conditions of nutrition. The sporangiospores fuse on germination; they swell enormously in water and produce germ tubes which fuse in pairs, and in a nutrient solution the fused tubes gave rise to hyphæ in which conidia developed promptly; but hyphæ arise also from individual spores. The writer records the occurrence of abundant material in slime fluxes on elm trees, found after her paper had been handed to the publisher. A. L. S.

Systematy of Mucors.—ADALBERT BLOCHWITZ ("Zur Systematik der Mucorineen," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 329–34, 1 text-fig.). After prolonged study Blochwitz has come to the conclusion that the type of branching is the distinguishing characteristic on which to base a classification of *Mucor* species. The sizes of sporangia and spores are too variable in any single specimen to be of service in determination. In branching he cites the angle of branching particularly, and the number of branches. Colour he finds of even less importance than in the *Aspergillæ*. A. L. S.

Sexuality in Mucors.—SOPHIA SATINA and A. F. BLAKESLEE ("Imperfect Sexual Reactions in Homothallic and Heterothallic Mucors," *Bot. Gaz.*, 1930, **90**, 299–311, 15 text-figs.). In the present paper are given the results of cultures of Mucors, both homothallic (including homogamic and heterogamic forms), and of the two sexual races of heterothallic species. The authors have found that all the races of a given species have the same sexual tendency. They publish results obtained from contrasts between hermaphrodites: zygospores were obtained when the contrasted races belonged to the same species; when with different species, imperfect sexual reactions only were developed. All these questions are treated in detail, and tables are given setting forth the results. A. L. S.

Inheritance in Ascomycetes.—B. O. DODGE ("Inheritance of the Albinistic Conidial Characters in Interspecific Hybrids in *Neurospora*," *Mycologia*, 1931, **23**, 1–50, 7 pls.). B. O. Dodge has given a review and a *résumé* of work done by him on *Neurospora*. There are two distinct races of the bread mould, *Neurospora sitophila*—one in which the growth is non-conidial and colourless, the other a brilliant yellow owing to the abundant production of *Monilia* orange conidia. An account of the matings, not only of these very different races, but of many others, is given. Dodge has been able to trace results of the fusion of a large number of the ascospores within the genus; numbers of hybrids were developed which produced fertile offspring. The general results are summarized, and Dodge suggests that it will possibly be through genetical cultures supplemented by cytological work that the questions regarding nuclear activities in sexual reproduction will become better understood. A. L. S.

Study of Discomycetes.—E. J. H. CORNER ("Studies in the Morphology of Discomycetes. III. The Clavulæ," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 107–20, 3 text-figs.). Corner has described the development of the clavate ascocarps in several genera of Ascomycetes—*Mitrula pusilla*, *Microglossum viride*, etc. In *Mitrula viride* the development is angiocarpic, in other species of the genus it is gymnocarpic. In the Clavulæ the ascogenous hyphæ arise from several ascogonia giving a compound fruit, but in some forms they originate from sterile hyphæ in the subhymenium. Corner has described the upward growth of the stalk hyphæ, and the formation of the fruiting body. There is a primordial corticated shaft of hyphæ, at the distal end of which the hymenium is formed. There is, in most forms, no definite marginal growth. The probable relationship between the different forms is discussed at length. IV. "The Evolution of the Ascocarp" (*tom. cit.*, 121–34, 1 text-fig.). Corner continues his study of fruit development, and traces the history of the many different forms of apothecium: the stipitate, substipitate, turbinulate, cleistocarpic, etc., the disappearance of the stem being taken to signify a certain degeneration. He also discusses the function of the ascocarp in the formation and dispersal of spores. A. L. S.

Urnula craterium in Sweden.—CARL TH. MÖRNER ("Discomyceten *Urnula craterium* (Schw.) Fr.—En för Sverige ny Storsvamp," *Svensk. Bot. Tidskr.*, 1930, **24**, 301–10, 1 text-fig.). Mörner here records the first finding of this large "Peziza" in Sweden. He gives the history of its discovery and its occurrence in very widely separated countries; first recorded by Schweinitz from North Carolina, but occurring also in Northern America and in East and West Europe. Mörner gives a full description of the fungus and adds a list of the literature in which it has been described or cited. A. L. S.

British Xylariaceæ.—JULIAN H. MILLER (*Trans. Brit. Mycol. Soc.*, 1930, **15**, 134–54, 2 pls.). Miller has reviewed the genera *Hypoxylon*, *Daldinia*, and *Camarops*, as known in Britain. He explains the terms to be used in description: the stroma is the whole sterile tissue, the outer layer the ectostroma, the tissue immediately below, in which the perithecia are initiated, the entostroma; the ostiolar neck, as extruded or not extruded beyond the ectostroma, is one of the distinguishing characters. Under the first group he includes *Hypoxylon ustulatum*, known as *Ustulina vulgaris*. In the genus *Camarops* he describes one species, *C. polyspermum*, rare in Europe, but common in tropical America. *Daldinia concentrica*, with its concentric rings in the fruiting body, is our sole specimen of a small genus. A. L. S.

Study of Ascochyta.—HEINZ RATHSCHLAG ("Zur Spezialisierung der auf *Vicia Faba* parasitierenden *Ascochyta*," *Phytopath. Zeitschr.*, 1930, **2**, 493–501, 4 text-figs.). Rathschlag has undertaken to clear up the ambiguity between *Ascochyta* on *Pisum sativum* and *Ascochyta* on *Vicia Faba*. The latter he finds to be a strongly specialized form, and the higher fruiting form *Mycosphærella pinodes* is unassociated with it. The *Mycosphærella* has been definitely proved to be the higher stage of *Ascochyta Pisi* Lib. A. L. S.

Study of Phomopsis.—GLEN GARDNER HAHN ("Life-History Studies of the Species of *Phomopsis* occurring on Conifers," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 32–93, 29 text-figs., 3 pls.). G. G. Hahn has given a very full account of the *Phomopsis* species associated with conifer diseases, especially *Phomopsis Pseudotsugæ*, of the Douglas fir. The different forms were isolated and cultured on sugar-cornmeal agar, but the best perithecial development was secured on "natural media"—twigs of the host trees. Methods of culture adopted are described. There is a detailed account of the genus, *Phomopsis*, its appearance and association with other life stages, and the significance of the elongated, narrow secondary bodies—spores or paraphyses. Hahn definitely accepts them as spores. One species, *Phomopsis occulta*, has been proved by culture to be the imperfect stage of *Diaporthe conorum*, which occurs on 14 host genera in North America and Europe; *P. abietina* is limited to a single host in Germany and France. A list is given of the eight accepted conifer species and of the papers that have direct bearing on the subject, 67 in all. A. L. S.

Variations in Botrytis.—B. BARNES ("Variations in *Botrytis cinerea* Pers. induced by the Action of High Temperatures," *Ann. Bot.*, 1930, **44**, 825–58, 1 pl., 5 text-figs.). A full account of observations on the development of *Botrytis cinerea* in cultures subjected to similar temperatures and culture media. The results show that the heating of the spores before they were sown on the media had considerable effect on growth. Several variants were observed: these are described and discussed. One special feature was the development of a pink pigment in the mycelium. Barnes finds that there is evidence of an association between the occurrence of pink pigmentation in the fungus and weakness of constitution due to the initial superheating. Owing to high temperatures, 424 cultures of the 520 inaugurated failed to develop growth, 12 formed strongly modified (variant) colonies, 64 yielded slight variations, and 20 were normal. A. L. S.

Parasite of Hemileia.—R. L. STEYAERT ("*Cladosporium Hemileia* n. sp., un Parasite de l'*Hemileia vastatrix* Berk. and Br.," *Bull. Soc. Roy. Belg.*, 1930, **13**, 46–7). Steyaert states that the coffee disease rust, *Hemileia vastatrix*, is rare in the Belgian Congo, but a considerable proportion of these rusts were found to be infected by a mould. It was determined as *Cladosporium Hemileiæ* n. sp., differing in various particulars from other moulds, one of which, *Cl. æcidiicola*, is a parasite of various æcidia of rusts. A. L. S.

Study of Helminthosporium.—HEINZ RATHSCHLAG ("Studien über *Helminthosporium Avenæ*," *Phytopath. Zeitschr.*, 1930, **2**, 469–92, 6 text-figs.). Rathschlag has given a detailed study of this fungus and its relation to the host-plant. It is known as a leaf-fungus, colouring the infected areas a deep brown, and frequently destroying the leaf. The research includes a study of the gonidia, the mycelium with gonidial formation, the higher fruiting form (*Pleospora Avenæ*), and an account of infection and its results. Infection takes place by perforation of the epidermis or by entrance through the stomata. Tests were made of many different

varieties of *Avena sativa*, but no difference in susceptibility was proved. The perithecial form was produced in artificial cultures. In order to avoid infection the writer recommends treatment of the seed. A. L. S.

Dissemination of Rusts.—K. Schilbersky ("Der Berberitzenstrauch und die Schwarzrostfrage," *Phytopath. Zeitschr.*, 1930, **2**, 615–37). The author of this paper recapitulates the life-stages of the corn rust, *Puccinia graminis*, and the part played by Berberis in spreading the disease. Special attention is given to the question of moisture and rainfall. The æcidia represent the haplont stage, the æcidiospores germinate and give rise to the diplont teleutospores on Gramineæ, which again infect the Berberis. The pycnidia are ruled out as having no known function. The author also cites the uredospores as agents in reinfecting grasses, and thus carrying on and widely disseminating the rust disease. He decides, however, that the barberry is of extreme importance, and he considers that, if it were destroyed, the influence on the spread of the rust would be considerable. A. L. S.

American Rusts.—H. W. Thurston, Jun., and F. D. Kean ("Notes on Some Rust Collections from Colorado, Wyoming, and South Dakota," *Mycologia*, 1931, **23**, 77–82). The authors print the list of 12 genera and 53 species of rusts from a region the rusts of which were little known. They have added materially to the knowledge of distribution, and have recorded new hosts for several rusts. *Puccinia* and *Uromyces* are the genera most fully represented. A. L. S.

Smut on Selaginella.—T. C. N. Singh ("A Note on the Occurrence of a Smut on *Selaginella Chrysocaulos*," *New Phytologist*, 1930, **29**, 294–6, 3 text-figs.). The fungus was found at Mussoorie (India) on the stems and leaves of the *Selaginella* in dark irregular patches. It was determined as identical with a species very near to *Entyloma polysporum*. The material was inadequate for a study of the full life-history. A. L. S.

Biology of Rhizoctonia.—John E. Kotila ("A Study of the Biology of a New Spore-forming *Rhizoctonia, Corticium praticola*," *Phytopathology*, 1930, **19**, 1059–99, 5 text-figs.). Basidiosporous stages of *Rhizoctonia* have been proved in several instances. The author of the present paper has isolated a form which fruited in culture, forming hymenial cells, basidia, and spores; it has been determined as *Corticium praticola* sp. nov. As compared with *Corticium vagum*, also a *Rhizoctonia* fungus, *C. praticola* has a white mycelium and specific differences in the sizes of the basidiospores. This perfect stage has been obtained in artificial cultures and also by inoculation of *Alfalfa* plants. A renewed culture was made from the latter, and basidiospores again were obtained. The examination of the fungus and the cultures have been made under every possible condition of environment—humidity, oxygen, temperature and type of medium. A sterile form was also produced, the explanation of its occurrence being that of internal disturbances in the mycelium. The new species is homothallic. A long list of cited literature is given, amounting to 79 items. A. L. S.

Russula Spores.—M. and Mme. Fernand Moreau ("L'ornementation des spores de *Russula*," *Bull. Soc. Bot., France*, 1930, **77**, 310–24, 3 pls.). The authors have examined the many varieties of ornamentation of *Russula* spores: their work should be of service in determining species. They describe their methods of collecting and examining the spores. They found that there were several types, but that all originated when the spore was still immature; there were isolated verrucæ

or verrucæ united in part or wholly by lines, or the verrucæ themselves might form lines. They have argued from these results that the simplest form of ornamentation may be characteristic of the most advanced types of *Russula*. It is thus not possible to base any phyletic arrangement on the ornamentation. On the plates are represented a long series of spore types in this genus. A. L. S.

Rare Phalloid.—FRED J. SEAVER ("A Rare Phalloid from the New York Botanical Garden," *Mycologia*, 1931, **23**, 83–4, 1 pl.). A similar fungus was collected at Pittsburg, where it grew in abundance. It appeared in the New York Botanical Garden in 1928, and has grown there each year since, covering a large area. It has been proved to be probably identical with *Colus javanicus* Penzig, and has also been found in Cuba. A genus, *Pseudocolus*, was established to include species in which the arms arise from the stem. Seaver rejects the distinction, as at a young stage there is no stem. A. L. S.

Sexual Mutations in Fungi.—RENÉ VANDENDRIES ("La tetrapolarite et les mutations sexuelles chez *Hypholoma hydrophilum*," *Bull. Soc. Roy. Belg.*, 1930, **13**, 26–35, 1 text-fig.). This study continues the author's work on *Coprinus micaceus*, and, in general, confirms the conclusions there arrived at. A natural spore ejection was used, and it was found that a large majority followed the law of tetrapolarity. Certain spores were partially mutant, others were sterile with the majority of other spores, while certain individuals were able to copulate with all others, owing, as the author states, to mutations of the two genes. These phenomena are identified as similar to those found in *Coprinus micaceus*. These statements are verified, and the course of the work described in full detail. A. L. S.

Spore Membranes.—G. MALENÇON ("Observations sur les ornements des spores chez les champignons," *Arch. Bot. Bull. Mensuel*, 1929, **3**, no. 7, 121–9, 1 pl.). The author has set out to precise the exact development and formation of the "ornaments" on a great variety of fungus spores. He distinguishes two coverings of the spore—the endospore in contact with the spore contents, and an outer covering the epispore. In some cases, as in *Ciliaria asperior*, there is another outer covering or perispore. As regards development, the endospore by growth becomes double, giving rise to the epispore, encircled by a perispore which in this case shows ornamental projections. These have been proved to arise from the lower layer—the epispore; they are not simple excrescences. The same line of development has been traced in other genera and species—*Elaphomyces granulatus*, etc. The author also finds the same characters in other unrelated genera—*Lycoperdon*, *Hymenogaster*, etc. In these also he traces the formation to the perispore. Malençon finds the perispore frequent and widespread among fungi, but not always forming ornamentations. In some cases it disappears at maturity, leaving a mucous membrane which is sometimes characterized by rugosities, as in *Hysterangium rubescens*, in which spores it may finally tear apart and reveal a smooth spore surface below. A. L. S.

Herbarium Specimens of Microfungi.—S. P. WILTSHIRE ("A Method for the Preservation of Petri-Dish Cultures of Fungi," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 93–5). The need of herbarium specimens for comparison of microfungi has long been experienced. Wiltshire describes in minute detail how this can be done. Cultures are prepared of maize-meal agar in a petri-dish in which the fungus is grown. When the mature stage is reached, the agar plate, by careful manipulation (which is described), is removed from the dish and placed on cardboard. Drying the specimen follows, and the culture film is placed in a waxed paper envelope. The

surface of the culture has thus not been disturbed, and the fungus can be examined in its well-developed form. These plates can not only be examined and sent by post, but can be shown on the lantern. A. L. S.

Type Cultures.—R. St. John Brooks and Mabel Rhodes ("A List of Fungi, etc., maintained in the National Collection of Type Cultures, 1930," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 155–63). The writers provide a list of the specimens in growth at the Lister Institute, both of fungi and of bacteria. The list comprises 770 separate species, which are ready for consultation. The curators desire the assistance of workers in the different fields to add to the numbers. A. L. S.

Mycorrhizal Fungi.—Beniamino Peyronel ("Simbiosi micorrizica tra piante alpine et basidiomiceti," *Nuovo Giorn. Bot. Ital.*, 1930, **37**, 655–63). Peyronel has traced the association of the Mycorrhiza of Alpine shrubby plants to various species of Basidiomycetes. They belong mostly to the genera *Cortinarius* and *Russula*. In *Vaccinium uliginosum*, in addition to the endotrophic form of the Ericaceæ, he found an ectotrophic association with a *Cortinarius*. He found also a double infection in *Arctostaphylos Uva-ursi*, the ectotrophic species being a *Russula*. Peyronel also records his observations on the size of the larger fungi as affected by altitude; he found, for instance, no difference in size between the *Cortinarius* species in symbiosis with *Helianthemum vulgare* at 1,350 metres altitude and those at 2,200–2,350 metres. A. L. S.

Mycorrhiza in Hepatics.—Theodora B. Auret ("Observations on the Reproduction and Fungal Endophytism of *Lunularia cruciata* (L.) Dumortier," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 163–76, 8 text-figs.). Auret gives a description of the Hepatic, which was found in South Africa on slightly alkaline soil; if non-alkaline, the internal fungus was scarcely developed. The female plants alone were found, and contained a fungus confined to a definite zone below the assimilating tissue. The appearance of the fungus is described; no fructification was observed in the host tissues. When the fungus was isolated and grown on suitable media, the pycnidia of a *Phoma* were produced in abundance. The fungus produced no harmful effects on the *Lunularia*; there was no discoloration nor any indication of disease in any of the most heavily-infected plants. The writer concludes that there is here no true symbiosis, but rather harmless parasitism on the part of the fungus. A. L. S.

Fungal Symbiosis in Grasses.—Beniamino Peyronel ("Simbiosi fungina tipo '*Lolium*' in alcune graminaceæ del genere '*Festuca*,'" *Nuovo Giorn. Bot. Ital.*, 1930, **37**, 643–8). The *Lolium* fungus has been known for a long time. Peyronel sketches its association with the grass from the seed to the vegetative organs of the growing plant. He has now examined 30 other grasses collected from various localities and has determined the presence of a fungus of the same type in three species of *Festuca*—*F. spadicea*, *F. duriuscula*, and *F. glauca*. The fungus follows the same course of development as in *Lolium*. It invades the ovary from the base surrounding the ovule; the fungus was entirely different from mycorrhizal forms. None of the other grasses examined was invaded by a fungus. A. L. S.

Rootlets of Amyelon.—A. C. Halket ("The Rootlets of '*Amyelon radicans*' Will., their Anatomy, their Apices and their Endophytic Fungus," *Ann. Bot.*, 1930, **44**, 865–905, 2 pls., 6 text-figs.). In examining these rootlets, Halket found the endophytic fungus (previously noted by Osborne) so constant as to form a distinguishing character of the cortex. The hyphæ were in the inner region of the cortex

inter- and intracellular, and formed structures similar to the vesicules and arbuscules characteristic of *Mycorrhizæ*. The physiological relations between root and fungus were of the same nature as in other *endomycorrhizæ*. The septate mycelium indicated relationship with Basidiomycetes or Ascomycetes rather than with Phycomycetes. The fossil remains of *A. radicans* have been found to contain a similar *endomycorrhiza*. A. L. S.

Survey of Exotic Fungi.—E. M. WAKEFIELD ("Fungi Exotici: Past Work and Present Problems," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 12–31). The subject of exotic fungi was chosen by E. M. Wakefield for her address as President of the British Mycological Society. She stresses the advantage of looking back and taking stock of previous work and workers in any field of knowledge. As in other branches of botany, economic usage was the beginning of interest in fungi. One of the first accounts is by Hieronymus Bock, who dismissed them as the "superfluous moisture of the earth, trees, etc." The earliest British record dates from Ray (1690), three fungi finding place in a list of Jamaican plants. Other early students and collectors were Banister (1704) in Virginia, and Plumier in the West Indies, 1689–97, and the work of other great students, such as Rumphius, also at the end of the seventeenth century. Other contributors to a knowledge of exotic fungi were Thunberg (*Flora japonica*, 1784), and Swartz (*Flora Indiæ occidentalis*, 1788). The science of fungology was henceforth well established, and the list of distinguished workers increased with the opportunity of travelling. A full account is given of the progress of our knowledge, helped by many workers in other lands, and the workers one by one have been noted and this special contribution described. There was much intercourse between the students of various countries and exchange of specimens. For modern study the need of systematic lists of the fungi of our colonies is necessary for continued and sure determination, and also it is desirable that trained mycologists should be settled in all our Dominions. The study of plant pathology makes large demands on the time of the mycologist; but the author concludes by begging "the pathologist, in the absence of a systematic mycologist, to bear the matter in mind, to collect and observe all he can, and to send his collections home for determination." A. L. S.

Effect of Light on Fungi.—JESSIE H. GROVE ("*Helotium scutula* (Pers.) Karst.: its Growth, Development and Response to External Stimuli, with Some Observations on *H. cyatheoides* (Bull.) Karst.," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 177–92, 9 text-figs.). The fungus *Helotium scutula* was found in abundance on dead stems of *Helianthus* sp. in late autumn; the apothecia were borne on elongated stalks and turned towards the light. This response to light was examined in different aspects. If young apothecia were exposed at the same time to the influence of light and gravity, the former had the greater influence. The fruit bodies are initiated in darkness, but fail to develop unless light is present, though, after the early stages in light, development continues in darkness. A comparison was made with *Helotium cyathoideum*; that species developed apothecia and mature spores in the dark, though growth was considerably retarded, and there was no effect of light or gravity in the direction of growth of the apothecia. The relation to the tissues of the *Helianthus* was also studied: the hyphæ occupied the cells and passed from cell to cell through the pits in the walls. The development of the fruiting bodies seemed to be apogamous. A. L. S.

Early Phases of Fungi.—G. HAMILTON MARTIN ("Certain Early Developmental Phases common to Many Fungi," *Phytopathology*, 1930, **19**, 1117–23, 2 pls.). The writer points out that in many cases of disease in plants, such as anthracnose

die-back, scab, etc., it is impossible to place the parasite in its genus on account of the similarity of the early stages of many different fungi. *Pseudosaccharomyces* and *Pseudofumago* are the two form genera of most frequent occurrence, budding and fumagoid phases of which recur frequently. A. L. S.

Sectoring in Cultures.—R. N. Sahai Vasudeva ("On the Occurrence of 'False Sectors' in Culture of *Fusarium fructigenum* Fr.," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 96–101, 1 pl.). Vasudeva had observed unusual sectoring in cultures of *Fusarium fructigenum*. Various culture experiments are described at length—the media used, the depth of the medium and its composition, and the nature of the sectors produced. It was finally proved that on shallow plates of medium containing an acid phosphate diverging sectors were formed, but as these reverted to the parent form in recultures, it was proved that they were not true sectors. A. L. S.

Field Mycology.—E. M. Wakefield ("The Petersfield Foray," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 1–4). A description of the country visited, and the conditions of moisture, temperature, etc., as affecting the fungus growth of the district, is given. The smaller forms of Pyrenomycetes, Discomycetes and Deuteromycetes were, as usual, the most abundant at the spring forays. The woods were mostly of beech, and yielded few of the larger fungi. A short list of Mycetozoa, supplied by H. J. Howard, is added. A. L. S.

Autumn Foray.—E. M. Wakefield ("The Bristol Foray," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 4–12). A description of the territory explored, with reference to fungus growth, is given by E. M. Wakefield. The dry summer had not been conducive to fungus growth, and many of the very common species were lacking; but, as usual in such conditions, a number of quite rare species, such as *Amanita echinocephala*, *Lepiota sistrata*, etc., were found. The author also notes the occurrence of the very rare *Polyporous sordescens*, brought to the meeting from another district. A surprisingly long list of species found is given. A. L. S.

Fungus Morphology.—Illo Hein ("Studies on Morphogenesis in *Agaricus* (*Psalliota*) *campestris*," *Amer. Journ. Bot.*, 1930, **17**, 882–914, 4 pls.). Hein begins his study by a clear definition of terms such as plectenchyma and the tissues generally, and also a general account of spores, hyphæ, mycelium, rhizomorphs, etc. The main body of the work opens with carpogenesis—that is, development of the fruiting body from the earliest pinhead stage; he notes the clamp connection and their significance in the mycelium previous to the carpogenetic. He then passes on to "Organogenesis and Morphogenesis of the mature Basidiocarp." In this section are included the formation of the stipe and the pileus, and later of the lamellæ. All these structures, their origin and development, are described at length. The morphogenesis of basidium and spores is not included, being still incomplete.
A. L. S.

Colour Mutations.—Adalbert Blochwitz ("Mutationen der Konidienfarbe bei Aspergillen," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 325–8). The author observed that in strong light the violet spores of *Aspergillæ* became brown. He had noted that both the brown and the violet colours were present in certain species, also that species such as *A. niger*, though brown in intense light, is variable as to the colouring—brown, black-brown and violet shades occurring together. Under culture conditions the brown colouring gave way to more violet tints in *A. violaceo-fuscus*. The various results of cultures are described, but the author failed to prove true mutation. A. L. S.

Characters of Fungus Hyphæ.—R. C. THOMAS ("Composition of Fungus Hyphæ. II. Sclerotinia," *Journ. Amer. Bot.*, 1930, **17**, 779–88). The research was made mainly by macrochemical methods, the fungus having been cultured for the purpose. There has been great discussion as to the nature of fungus cellulose. Thomas has repeated the ascertained facts as to the presence of fatty acids in the cell walls; the outer covering was determined to be an acidic carbohydrate which responded to the tests for callose; underlying the callose was a basic skeleton of chitin. The acidic character of the callose was due to an ethereal phosphate. In the alcoholic and ether extracts the presence of phosphoroid lecithin was demonstrated. The presence of fatty acids in the fungus cell walls accounts for the apparent resistance or inactivity of the hyphæ toward reagents, such as alkalis, acids, and dyes. The author quotes the work of Mangin on callose, the latter having demonstrated its presence in many fungi, frequently replacing cellulose.

A. L. S.

Parasite on Myrica Gale.—C. E. FORSTER ("A Note on a Rare Parasitic Fungus on *Myrica Gale* L.—*Ovularia destructiva* (Phil. & Plow.) Massee," *Trans. & Proc. Bot. Soc., Edin.*, 1930, **30**, 244–5). The parasite occurred at the end of the twigs, forming a thick greyish-white band on the surface. The hyphæ form a stroma beneath the cortex and penetrate the underlying tissues. The twigs are stunted, though the damage is not severe. The fungus was first reported from Lincolnshire in 1877 as *Ramularia destructiva*. A. L. S.

Apple Twig Canker.—H. G. THOMAS and A. B. BURRILL ("A Twig Canker of Apple caused by *Nectria cinnabarina*," *Phytopathology*, 1930, **19**, 1125–8, 1 text-fig.). The parasitic nature of the fungus was proved by means of culture and subsequent inoculation of young apple trees. Natural infection took place at or near the point of detachment of the fruit. From inoculated wounds the fungus was traced into the tissues. A. L. S.

Grape Disease.—H. WORMALD ("Ripe Rot of Grapes," *Gard. Chron.*, 1930, **88**, 498–500, 5 text-figs.). The disease was traced by Wormald (following growths by culture) to the fungus *Glœsporium fructigenum*, the conidial stage of *Glomerella cingulata*. The disease is fully described, and measures are recommended for controlling the fungus growth under greenhouse conditions. A. L. S.

Banana Wilt.—C. W. WARDLAW ("The Biology of Banana Wilt (Panama Disease). II. Preliminary Observations on Sucker Infection," *Ann. Bot.*, 1930, **44**, 917–36, 74 text-figs.). The object of the paper is to give an account of the origin of Banana Wilt as regards the attack of the fungus, *F.* (*Fusarium*) *cubense*. The research had reference to the early stages of sucker infection. Inoculated in closed chambers, there was a considerable infection both of susceptible and otherwise immune varieties. It was noted that the reaction of the sucker was the formation of a protective suberised tissue. The fungus killed the cells ahead by the diffusion of toxic fungal secretions. Experiments were made to test the rate of penetration of the parasite and the confirmation of the resistance of the wood vessels. Finally the association of weevil-borers as possible agents in infection is described, as also an account of subsequent fungal penetration into the plant bases. *Fusarium cubense* is principally a wound parasite, and any damage done by insects, etc., would provide means of entrance into the host plant. The many illustrations are chiefly of the plant tissues and their invasion by the *Fusarium*. A. L. S.

Brown Rot Fungi.—H. WORMALD ("Further Studies of the Brown Rot Fungi. IV. *Sclerotinia fructigena* as the Cause of an Apple Canker," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 102–7, 1 pl.). The author gives the history of a severe

attack of apple canker at the East Malling Research Station. The fruit attacked is known as the Melon Apple, which has been grown in this country for 80 years. The wilting of the leaves first drew attention to the disease. The apples were attacked by *Sclerotinia fructigena* in the *Monilia* stage. The infection destroys the apples and spreads to spurs and branches, on which later are developed the *Sclerotinia* stages of the fungus. This species differs from *Sclerotinia cinerea* in that the latter, though it forms cankers, does not produce the perfect *Sclerotinia* stage. Records are given of other apple trees being similarly attacked. The branches and spurs are girdled by the fungus, and the parts terminal to the fungus are killed. A. L. S.

Lichens.

Field Lichenology.—R. PAULSON ("Lichens of the Bristol Foray," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 11–12). Paulson describes the conditions encountered in collecting lichens so near to a large town. A late rainfall just before the foray was favourable to the revival of dried-up thalli, and species were found in good condition on the trunks of old trees, on walls, and on rock masses. On the latter were found some large patches of *Crocynia lanuginosa*. Sixty-six species and three varieties were listed. A. L. S.

Siamese Lichens.—R. PAULSON ("Lichens from Kaw Tao, an Island in the Gulf of Siam," *Journ. Siam. Soc. Nat. Hist. Suppl.*, 1930, **8**, 99–101). The lichens named and listed consist largely of crustaceous specimens on the bark of small trees, the cortex of which may be entirely covered with the lichen growth. One new species, *Phyllopsora viridis*, has been described by the writer. It grew on a granite rock. A. L. S.

Scandinavian Lichens.—C. F. E. ERICHSEN ("Neue skandinavische Flechten," *Nyt. Mag. Naturvidensk.*, 1930, **68**, 159–65). In the course of an expedition to Sweden and Norway the author picked up three crustaceous lichens which proved to be new to science, two of them, *Arthopyrenia Orustensis* and *Verrucaria Zschackeana*, from the sea-shore, the third, *Bacidia Lyngeana*, on pine branches. Erichsen compares these carefully with associated forms and so justifies the formation of his new species. A. L. S.

Mexican Acarosporæ.—A. H. MAGNUSSON ("The Lichen Genus *Acarospora* in New Mexico," *Meddel. Goteborgs Bot. Trädgärd*, 1929, **5**, 55–72). Specimens to the number of 95 were sent to Magnusson by B. de Lesdain, unfortunately too late for inclusion in his monograph of *Acarospora*. They had been mostly collected near Las Vegas, 1,947 feet above sea-level; they grew on stones, chiefly sandstone or volcanic. Magnusson determined 20 species, four species also from Europe, and seven new to science. Full descriptions are given of all. Evidence was present of the nitrophilous habitat in several instances, and two new species, *A. interjecta* and *A. succedens*, were saprophytic on other lichens. Most of the specimens are now in Herb. B. de Lesdain, though fractions of all have been retained by Magnusson. A. L. S.

South American Lichens.—GUST. O. A. N. MALME ("*Porinæ et Phylloporinæ* in Itinere Regnelliano primo collectæ," *Ark. För. Botanik*, 1930, **23**, 1–37). Malme deals first with the genus *Porina*, a cosmopolitan genus, but more abundant in moderate or subtropical regions than in the north; thus more species were collected in Rio Grande do Sul than in the tropical Matto Grosso. Malme found also that they favoured moist or slightly shaded positions, and were

often abundant in primitive forests when other lichens were scarce. They cannot grow under direct insolation or in dry situations. Many of the species found were new to science and belonged to the section *Segestria*, with perithecia immersed or partly immersed in the bark. Malme describes 11 species of *Phylloporina* epiphytic on various leaves and also most of them new. He considers that these two genera differ mainly in their ecological aspects, the latter growing on leaves and thus closely associated with *Strigula*. They grow on leaves of ferns and Monocotyledons (palms, etc.), more rarely on rather thin leaves of Dicotyledons, and they form crowded communities with other lichens. A. L. S.

Chinese Lichens.—A. Zahlbruckner ("Symbolæ Sinicæ. Botanische Ergebnisse der Expedition der Akad. der Wissensch. in Wien nach Sudwest China, Handel-Mazzetti, 1914–1918, III," *Lichenes*, 1930, 1–254, 1 pl., 1 text-fig, Julius Springer, Wien). In the introduction Zahlbruckner gives an account of previous publications connected with the Lichens of China from a collection of three species made by Seeman in Hongkong down to Paulson's account of those brought home by Gregory (1928). The whole number now known for China reaches 177 genera and 717 species. The present compilation is the largest and most comprehensive yet published, and deals mainly with the Handel-Mazzetti collections in the south-western districts. The general flora is mostly northern in character, with intrusions from Central China. The larger number resemble those of Central Europe, which have evidently arrived by way of the Siberian forest region, the latter, however, still unknown as to its lichen flora. Many species from the higher reaches common to Yunnan and West-Szechuen are absent from other Chinese localities, probably owing to the dry character of these two districts. Middle China contains many tropical lichens, and has little affinity with those of Japan. But in Fudschow, on the southern border, and in the tropical parts of Yunnan, lichen vegetation is distinctly tropical. The best-known regions are those of Yunnan and Szechuen, and they include mountain, temperate, and tropical conditions, giving a great variety of lichen genera and species. Zahlbruckner finds that about 40 species are common to all districts, but not peculiar to China. Many new species are described, but cannot be judged as endemic until more is known of neighbouring countries. It is, however, specially noted that in the whole of China families and genera are lacking which are common in other parts of the world; such are *Sphærophorus*, Paratheliaceæ, Dirinaceæ, Roccellaceæ, and Cœnogoniaceæ. Zahlbruckner has described many new species with several new sections of genera previously known, and as new genera *Haplodinia* (Lecanactidaceæ), *Buelliastrum* (Lecideaceæ), *Leptopterygium* (Lichinaceæ), and *Huilia* (Pannariaceæ). He has seen cause to separate *Parmoparmelia* from *Anzia*. Keys to the species are given for each genus. In *Pertusaria* seven of the species given are new to science. The solitary text-figure represents an enlarged view of the peculiar yellow thallus of *Acarospora discurrens*. The plate gives a view of the wide-spreading *Acroscyphus sphærophoroides* Lév., a monotypic genus recorded from the Himalayas and the only representative. The genera of the higher mountains are those of Europe, but the species are new. A. L. S.

Lichenological Contributions.—C. F. E. Erichsen ("Lichenologische Beiträge," *Hedwigia*, 1930, **70**, 216–33). Erichsen publishes in this paper a considerable number of lichens, most of them from localities in Schleswig-Holstein, and the large majority new to science. There are included new species of (*Lecidea*, *Buellia*, *Graphis*, etc., the latter of particular interest, as Graphideæ are rather rare in North Germany. The species *Graphis neglecta* Erichs. had large 11-septate

spores; it was of the *G. elegans* type, with ribbed margins. Finally a key is given to sterile thalli frequently occurring in the lowlands of North Germany. A. L. S.

Swedish Lichens.—A. H. MAGNUSSON ("New or Interesting Swedish Lichens, VI," *Bot. Not.*, 1930, 459–76). Most of the lichens here recorded had been found in recent years, but several new forms have been determined by Magnusson, and the distribution has been much enlarged. Most of the records are new for Sweden, and full descriptions are given. He upholds Erichsen's new species *Lecanora pityrea*, previously considered a sorediate form of *L. varia*.

Bulgarian Lichens.—Ö. Z. SZATALA ("Beiträge zur Flechtenflora von Bulgarien, II," *Mag. Bot. Lapok*, 1930, **29**, 58–104). In this second contribution to the lichen flora of Bulgaria are included 277 species, with many varieties and forms. Szatala gives a sketch of the territory explored, comprising lowland as well as mountain localities. He describes five new lichens belonging to different genera—*Verrucaria, Collema, Acarospora, Pertusaria,* and *Alectoria*.

Swedish Lichens.—GUNMAR NILSSON ("Lichenologiskabedrag III," *Bot. Not.*, 1930, 344–57, 1 text-fig., Swedish with German *résumé*). Nilsson has given special attention to marine *Verrucariæ*, hitherto rather neglected in Sweden. Erichsen had found three species—*V. scotina*, *V. Erichsenii*, and *V. microspora*. Nilsson has now added *V. centhocarpa*, and notes various new localities for other forms. He has also been successful in adding to the localities of *Xylographa abietina* and of *Cetraria norvegica*. He has appended to the paper a long list of the literature bearing on lichen distribution. A. L. S.

Lichen Parasites.—KARL KEISZLER ("Die Flechtenparasiten," *Rabenhorst's Kryptogamenflora*, 1930, **8**, 1–712, 135 text-figs.). In this volume are included the fungi that grow on the thalli of lichens, all of them ranked by the author as parasites. He has also included such organisms as Myxobacteriales and Myxomycetes that may have chanced to spread on to the decaying thallus of lichens, and also species of the larger fungi, such as *Corticium* and *Peniophora*, that inhabit the bark of trees and may thus also overspread lichens. Keiszler explains that he has given these instances of overgrowth for the sake of completeness. An index of species, not only of the parasites but of the lichens parasitized, completes the volume. A. L. S.

Gonidia of Lichens.—R. CHODAT ("Nouvelles recherches sur les gonidies des lichens," *Compt. rend. Acad. Sci.*, 1930, **191**, 469–71). Chodat gives here a review of recent work on lichen gonidia. He reaffirms the results arrived at by himself and other workers—that practically each lichen species has its own gonidial species. Thus *Solorina saccata* is associated with *Coccomyxa saccatæ*, *Solorina crocea* with *C. Croceæ*. To each species of *Cladonia* or *Peltigera* there belongs an algal species. *Cystococcus* algæ are found in *Cladonia* and *Parmelia*; rarely in any lichen occur forms of *Pleurococcus* (*Protococcus*). Chodat had definitely isolated from *Coniocybe* sp. a true *Stichococcus* which is not a form of *Pleurococcus*. He affirms that in none of his cultures from lichens has he found a gonidium that corresponds in its cellular character, or in its cultural behaviour, to the alga that forms the green coating of trees which has been determined by himself as *Pleurococcus Nagelii*. The *Pleurococcus* in the lichen corresponds to the type *Pl. monas* or to *Pl. Chodati*. There are still other species of *Pleurococcus* in *Toninia vesicularis* and in *Verrucariæ*. A. L. S.

Vainio's Life and Work.—A. H. MAGNUSSON ("Edward August Vainio (1853–1929)," *Ann. Crypt. Exot.*, 1930, **3**, 5–12, 1 pl.). Magnusson has given a valuable account of the contribution to Lichenology by Vainio from 1875 to the latest publication in 1925. His life's work is given in detail, and is followed by the long list of his published works. His studies embraced the whole world, east and west, and his books and papers are standard works. He has left unfinished a Lichen Flora of Finland, though several of the most important and difficult groups are published. A. L. S.

Mycetozoa.

Field Collection.—G. LISTER ("Mycetozoa Gathered During the Bristol Foray," *Trans. Brit. Mycol. Soc.*, 1930, **15**, 10–11). Experience and knowledge were demanded in the collection of Mycetozoa after a very dry season. Many of the specimens had matured weeks before, and were in a weathered, mouldy condition, but after some rain the developing plasmodia of *Badhamia* spp. and *Diderma floriforme* were found. Thirty-three species were collected, including the rather rare *Lachnobolus congestus* and *Perichæna chrysosperma*. A. L. S.

TECHNICAL MICROSCOPY.

The No. 29 Beck London Microscope.—This new instrument is of novel design as regards the slow motion fine adjustment and also the mechanical stage.

Modern grinding and broaching machines have rendered it possible to produce commercially circular ground steel rods and holes which are parallel and of uniform diameter to an accuracy of about a quarter of a thousandth of an inch.

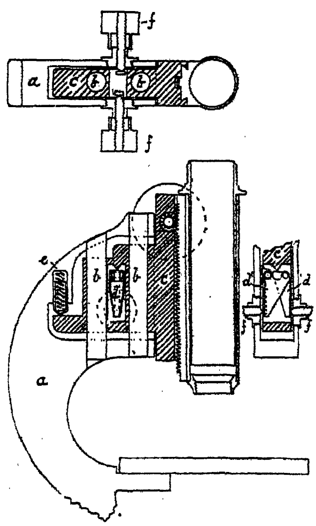


FIG. 1.

Taking advantage of this accuracy, the No. 29 Beck Microscope has been made with a fine adjustment which consists of a fitting composed of two steel rods, *b*, *b* (fig. 1), fixed into the limb, *a*, of the microscope, upon which the fitting *c*, carrying the microscope body, slides, there being two cylindrical holes in the fitting which accurately fit the two bars, leaving a fraction of a thousandth of an inch

for the lubricant. The rods *b*, *b* fit tightly into the limb, and the holes in the fitting *c* are bored in the same process as those which carry the rods, but broached out afterwards with a parallel broach by the minute amount required for the lubricant. The fittings are entirely enclosed by the limb, and it makes a fine adjustment fitting that cannot be readily damaged and which is singularly free from backlash, due to the perfection of the fitting surfaces.

This principle of circular rods and cylindrical holes has been applied in a different manner for the construction of the mechanical stage.

The square plate, *a* (fig. 2), shows the top plate of the mechanical stage seen from below. Its upper surface is perfectly plain for large culture plates or dishes, and can be provided with stage clips or a sliding ledge.

On the under-surface of this stage plate are two projections, *e*, *f*, through both

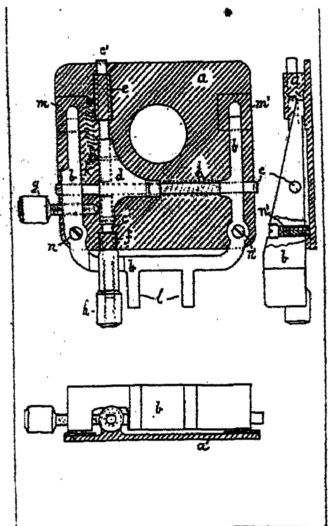


FIG. 2.

of which is bored a cylindrical hole. Through this hole a rod, *c′ c′*, slides. By means of a connecting block, *d*, the rod *c′ c′* is rigidly fixed to a second rod, *c*, which slides in cylindrical holes in the frame *b*, which forms the stage support and is attached to the limb of the microscope. The stage plate, *a*, is held down to the frame *b* by the cross-rod member, *c′ d c*, fitting through the holes in the frame *b*, and to prevent any rotation of the stage plate, *a*, on either of the rods as an axis, it rests on four points, *m m′* and *n n′*, which limit the travel of the top plate in all directions except those along the two bars of the cross-rod member. Actuating screws and springs produce the requisite movements. This stage has rather over ½ inch motion in each direction, which is sufficient for a blood count or for most specimens, and large specimens can be freely moved on the top stage to bring other portions under observation.

Studies in the Painting of Wood. I. Influence of Wood Structure on Paint Behaviour.—By J. H. HASLAM and S. WERTHAN (*Ind. Eng. Chem.*, 1931, 23, 226.) A description of the structure of woods (soft woods) as used for exterior building construction, and the effect of such structure on the penetration of paint. A method of staining sections of painted wood is given. The sections are

cut 10 to 15μ thick, and mounted on slides by means of egg albumen. The section, in the case of relatively new paint, is then allowed to oxidize for 8 to 10 hours. The wood fibres are now stained by 2 minutes immersion in a 1 p.c. solution of brilliant green. (If overstaining occurs, the section is washed with dilute alcohol and then water.) Staining of the oil is next done by immersion in a solution of Sudan III or IV or scarlet R. The section is passed through hydrochloric acid fumes to intensify the red colour of the oil. For permanent mounting, Allen's medium is used (a strained solution of gum arabic of the consistency of glycerol to which $\frac{1}{8}$ of its volume of glycerol and $\frac{1}{20}$ of its volume of formaldehyde are gradually added). To prepare section of paint films, the specimen is embedded in a mixture of 2 parts of beeswax and 1 part of resin, and frozen. The embedding material is subsequently removed with cold toluol. A. H.

Method of Preparing Micro-Sections of Rubber.—By TRACEY F. STEELE (*Ind. Eng. Chem., Anal. Edit.*, 1930, 421). Small blocks of bass wood, 30 × 30 × 12 mm., are cut and buffed perfectly flat. The surfaces to be in contact with the rubber are given a few coats of a thin rubber solution and allowed to dry. The sample of rubber, 8 × 2 × 0·5 mm., is placed between two such blocks, with its length at right angles to the grain of the wood and put in a vice under pressure for some hours. The block is then buffed down on a grinding wheel, leaving a projection of the wood holding the rubber. It is next fixed in the microtome clamp, given some coatings of liquid air, and sections cut. For permanent mounting, use a dry knife, otherwise a little glycerine can be applied. For permanent mounting, Aroclor 1257—an American product with a low melting-point and refractive index about that of glass—is recommended. A. H.

Chemical Micrurgy.—By R. N. TITUS and H. LE B. GREY ("A Method for Studying the Characteristics of Microscopic Quantities of Materials," *Ind. Eng. Chem., Anal. Edit.*, 1930, **2**, 368–71). The term micrurgy (micros = small, egon = work) was first applied to this type of investigation in biology and physiology by Péterfi (*Naturwissenschaften*, 1923, **6**, 81). In this paper a series of microtools are described and illustrated, designed to hold the sample of material for examination. To reduce strain during working, a binocular attachment with the tubes tilted towards the observer is preferred. For large particles, platinum-pointed tools are used, while for small particles, points of pyrex glass are suggested, and a method is described for the preparation of these latter under the microscope by means of an electrically heated platinum filament. A micro-pipette can be constructed from capillary tubes fitted into a 1 cc. Luer Tuberculin Fornier syringe. General working details are given. A. H.

The Detection of Carnauba Wax in Beeswax.—By L. R. WATSON, (*Chemist-Analyst*, 1931, **20**, 4). 8·5 m.gm. of the sample are dissolved in 2 c.c. of butyl alcohol in a thick-walled test tube (avoiding loss of solvent), the tube placed in water at 55–60° C. and allowed to cool to room temperature over a period of two hours. The temperature at which crystals form is noted, and this latter is influenced by the amount of carnauba wax present. The crystals are examined microscopically (x 200) with dark-ground illumination. The presence of very small amounts of carnauba wax destroy the usual bar or plate-like crystals of beeswax, giving in place star-shaped crystals. After 12 hours, and with uniform experimental conditions, the size of these crystals varies inversely with the quantity of carnauba wax present, viz., 10 p.c., 0·1 mm ; 5 p.c., 0·2 mm. ; 1 p.c., 0·4 mm. ; 0·5 p.c., 1 mm. A. H.

Newly Discovered Microscopic Structural Units of Wood Fibres.—By G. J. RITTER and R. M. SEBORG (*Ind. Eng. Chem.*, 1930, **22**, 1329). The fusiform bodies forming fibrils previously described (*Ind. Eng. Chem.*, 1929, **21**, 289) have now been resolved into small units, spherical in shape and having a diameter of about 0·45 micron or 4500 A. It is suggested that these units were not originally spherical, and that attempts should be made to prepare them under conditions of minimum swelling.

A. H.

NOTICES OF NEW BOOKS.

Early Theories of Sexual Generation.—By F. J. COLE, D.Sc.Oxon., F.R.S. 1930. x + 230 pp., 21 plates and text-figs. Published by Humphrey Milford, Oxford University Press, Amen House, Warwick Square, London, E.C. 4. Price 15*s*. net.

A Biographical Sketch of Francis James Blight, F.R.S.E., Publisher.—By GEORGE HAWKER, with a Foreword by J. W. EWING, M.A., D.D. 1931. xxii + 176 pp., 32 plates. Published by Elliot Stock, 7, Paternoster Row, London, E.C. 4. Price 10*s*. 6*d*. net.

The Technical Instrument Bulletin.—Edited by A. G. FREWIN. Vol. 3, No. 1. December, 1930. 16 pp., 19 illustrations. Vol. 3, No. 2. January, 1931. 16 pp., 10 illustrations. Published gratis by the Emil Busch Optical Co., Ltd., Diamond House, Hatton Garden, London, E.C. 1.

Microscope Record.—No. 22. January, 1931. 28 pp., 20 illustrations. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

The Science of Life.—By H. G. WELLS, JULIAN HUXLEY and G. P. WELLS. 1931. 896 pp., 350 illustrations and diagrams. Published by Cassell & Co., Ltd., La Belle Sauvage, Ludgate Hill, London, E.C. 4. Price 21*s*. net.

Bacteriological Technique.—By J. W. H. EYRE, M.D., M.S., F.R.S.Edin. 3rd edition, 1930. xii + 619 pp., 238 text-figs. Published by Baillière, Tindall & Cox, 7 & 8, Henrietta St., Covent Garden, London, W.C. 2. Price 21*s*. net.

The previous edition was published seventeen years ago, in 1913, and much has happened in bacteriological science since then. It is interesting, therefore, to see what the author has retained and what has been added. Generally speaking, the old well-tried methods are given, and comparatively few of the more modern procedures are included. The chapter on the microscope is very disappointing. The modern binocular microscope, with its great advantages to bacteriological workers in reducing eye fatigue, is not even mentioned. The paragraph on dark-ground illumination could have been amplified, and no mention has been made of the large aperture dark-ground condensers, or the special oil-immersion objectives which assist so largely in obtaining a satisfactory dark field with a minimum of trouble. In the chapter on stains no reference is made to Jensen's modification of Gram's method, which is now so extensively employed; while under stains for

the diphtheria bacillus, Neisser's method only is given. In such a work as this a greater variety is desirable.

In the chapter on media, however, a very extensive list of culture media is given, not only for organisms of medical importance, but also for soil and industrial bacteria. Methods of identification and study of micro-organisms are given in full detail, and the chapter is a complete and valuable one. The section dealing with the examination of water, milk, sewage, food, etc., is also admirable. There is, however, very little reference to any immunological methods, and the words "Wassermann" and "Widal" are not to be found in the index. It is a pity that the author has not referred more fully to the commoner immunological procedures. It would appear that he does not regard them as bacteriological in the strict sense of the word. The preparation and standardization of vaccines are not mentioned. There are a number of printing errors which could have been avoided.

In spite of these shortcomings, the book is a useful one, and contains a great deal of valuable information not usually found in the ordinary text-books of bacteriology, such as animal inoculation and the bacteriological examination of oysters. It will continue to be one of the standard works of reference. J. E. M.

British Scientific Instruments in Industry.—1931. 25 pp., 21 plates. Published gratis by the British Optical Instrument Manufacturers' Association, Ltd., 65, Holborn Viaduct, London, E.C.1.

This interesting brochure, published in connection with the British Industries Fair, 1931, contains much useful and suggestive information upon the purpose and utilisation of scientific instruments in industry. In addition to microscopes, refractometers, spectrographs, interferometers, and other instruments of laboratory and industrial application, the use of instruments in controlling the processes of manufacture, the testing of products, etc., is referred to. The brochure is well printed and illustrated.

The Œdogoniaceæ.—A Monograph including all the Known Species of the Genera Bulbochæte, Œdocladium, and Œdogonium.—By L. H. Tiffany, M.Sc., Ph.D., 1930. 256 pp., 64 plates, 647 figs. Published by the Author, The Ohio State University, Columbus, Ohio, U.S.A. Price: Cloth, $5.00; paper, $4.00.

Cell structure, reproduction and life-history are fully dealt with.

Reference is made to world-wide distribution of the three genera—Bulbochæte, Œdocladium, Œdogonium—the latter being strongly represented in North America by 205 species (varieties, forms) against 77 South America, 189 Europe, 49 Asia, 45 Africa, 35 Australia.

The author gives some interesting details of the habitats of Œdogonium, indicating the most abundant records in permanent ponds and scanty appearance in running waters. He points out the need of data concerning chemical and physical conditions; also hydrogen ion concentration in relation to algal growth and reproduction.

Three varieties, three species and one new form are recorded.

The family Œdogoniaceæ was first monographed by Wittrock (1874) and more recently on a more elaborate scale by Hirn (1900).

This latest publication, with its excellent, clean-cut line drawings of the various figures, which greatly assists in ready identification of species, makes a very desirable addition to the literature concerning the filamentous forms of freshwater algæ.

S. C. A.

Lecture Experiments in Optics.—By B. K. Johnson, F.R.M.S., Technical Optics Department of the Imperial College of Science and Technology. 1930. 112 pp., 90 text-figs. Published by Edward Arnold & Co., 41 and 43, Maddox Street, London, W. 1. Price 8*s*. 6*d*.

The purpose of the author is to describe the apparatus necessary for a course of lectures on experimental optics, together with the methods of use and demonstration. In this he has succeeded admirably, and has at the same time produced a book that will appeal to a much wider circle than is included in the student class. To those interested in microscopy the experimental basis of the elementary optical theory will particularly appeal. It does not pretend to be exhaustive, but it does provide a clear description of experiments the performance and understanding of which would be of benefit to any microscopist. J. E. B.

Enzymes.—By J. B. S. Haldane, M.A., 1930. vii + 235 pp., 35 text-figs. Published by Longmans, Green & Co., Ltd., 39 Paternoster Row, London, E.C. 4. Price 14*s*.

This subject has already been treated in the "Monographs on Biochemistry" series by the late Sir Wm. Bayliss, whose last edition, when compared with the present work, shows the great advances which have been made, especially in the physical chemistry of enzyme action.

The present author defines enzymes as soluble, colloidal organic catalysts, thus reducing to some extent the field covered. It is of interest to note, however, that in the chapter on theories of enzyme action it is stated that the colloidal properties of enzymes may become less apparent on purification. The catalytic nature of enzyme action, also, he considers to be applicable in every case, so that it is not the state of equilibrium reached, but the kinetics of the reaction which are dealt with.

In the chapter on the influence of hydrogen-ion concentration are reviewed the theories of Michaelis that the optimum for enzyme action is at the isoelectric point where the enzyme is present as uncharged molecules, and of Northrop that charged enzymes act on substrates of opposite charge; it appears from the examples that both types of action occur in different cases. Other chapters deal with specificity, co-enzymes, the poisoning of enzymes, and their purification and chemical nature.

The section on the theory of enzyme action is largely mathematical, and throughout a considerable knowledge of organic and physical chemistry is presupposed; there is, however, an appendix to Chapter VI on some recent work on carbohydrate chemistry. While this makes it a book primarily for the specialist, and therefore less easily read than "The Nature of Enzyme Action," its wealth of subject matter is of the greatest interest also to the more general reader.

J. E. B.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, DECEMBER 17TH, 1930, AT 5.30 P.M., PROFESSOR R. RUGGLES GATES, M.A., PH.D., LL.D., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

Richard Watson Frow, Lincoln.
Roderick Francis Hunwicke, B.Sc., A.I.C., Barnet.
Frank J. Myers, Ventnor, N.J.

Nomination Certificates in favour of the following candidates were read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

James Henry Dible, M.B., Ch.B., F.R.C.P., Liverpool.
Edward Charles T. Holsinger, Ceylon.
Frank Humphrys Lewis, Reading.
A. E. C. Smith, M.A., A.I.C., Southampton.

Donations were reported from :—

Mr. Chas. E. Heath, F.R.M.S.—
"The Beginner's Guide to the Microscope." Revised edn. By C. E. Heath.

Mr. Thomas R. Maynard—
"The Microscope Made Easy." 4th edn. 1754. By Henry Baker.

Trustees of the British Museum—
"Index Animalium." Parts XX–XXII.

Dr. E. W. Bowell—
A Zeiss Aspherical Projection Condenser and Stand.

Trustees of the Carnegie United Kingdom Trust—
One hundred and fifty pounds (£150).

Votes of thanks were accorded to the donors.

The Death was reported of :—
Colonel J. W. Gifford. Elected 1892.

A vote of condolence with the relatives was passed.

Mr. J. T. Holder, at the President's request, informed the Fellows of new regulations recently issued by the Commissioners of Customs and Excise with regard to obtaining industrial methylated spirits for medical and scientific purposes.

Mr. Holder observed that these new regulations are of no interest to those already holding a permit for duty free alcohol, but they are of great importance to independent scientific workers.

Under the old regulations five gallons was the minimum quantity obtainable, and for this a licence had to be obtained from the authorities. Under the new regulations any quantity up to and not exceeding four gallons at any one time can be supplied to any person authorised to receive industrial methylated spirits.

This is primarily intended to facilitate the purchase of the spirit by dispensing chemists, medical practitioners, dentists, universities, colleges, schools, and scientific workers, or any authorised user, and it is the duty of the supplying chemist to see that on each occasion he receives from the purchaser a requisition in the official form.

As to requisitions, any scientific worker or student may apply to the local surveyor or officer of Customs and Excise for authority to receive industrial methylated spirits. This authority is essential.

The surveyor will in future be able to deal with such cases himself, and, assuming that he grants the authority, will supply the necessary forms of requisition.

There is another matter of importance to scientific workers, with the exception of those holding a permit for duty free absolute alcohol. It is that industrial methylated spirits are now obtainable at absolute strength. A sample supplied by one firm, which has been tested, is 74 o.p., equalling 99·24 p.c. by volume.

The importance of this concession is only realised when the cost, a few shillings per gallon, is compared with that of pure alcohol.

This sample, it should be mentioned, has been denatured with methanol.

For the information of Fellows, Mr. Holder quoted the following paragraph from the recently issued notice by the Commissioners of Customs and Excise regarding the supply of industrial methylated spirits :—

> "In any quantity not exceeding four gallons at one time to any authorised user, i.e., any person authorised to receive industrial methylated spirits. This is primarily intended to facilitate the purchase of industrial methylated spirits by dispensing chemists, medical practitioners, dentists,

> veterinary surgeons, hospitals, nursing homes, universities, colleges, schools, and scientific workers. Sales may, however, be made under this provision to any authorised user, and it will be the duty of the supplying chemist to see that on each occasion he receives from the purchaser a requisition in the official form."

A vote of thanks was accorded to Mr. Holder for his remarks.

New Council.—The Secretary read the By-Laws relating to the election of Council.

Nominations to serve on the Council for the ensuing year were read and approved.

Exhibits.—Mr. A. P. Welch exhibited and described a tungsten ribbon-filament lamp for microscope use.

A vote of thanks was accorded to Mr. Welch for his exhibit and demonstration.

Prof. R. Ruggles Gates exhibited a culture demonstrating the metabolic symbiosis of Euglena and Rhodospirillum.

Prof. Gates observed that in 1923 a culture was set up in the Botanical Department, King's College, in a narrow glass cylinder about 18 inches high and $\frac{3}{4}$ inch internal diameter. The material was brought from the Department of Botany of the University of Bristol, where it had been cultured for some time. A small quantity of hay was finely chopped and then boiled in water. It was placed in the bottom of the cylinder, and the culture, together with a quantity of water, was added. The water was covered with a layer of heavy oil to prevent access of air, and a plug of cotton-wool was placed in the top of the cylinder. When examined some time afterwards, the culture was found to contain an abundance of Euglena and Rhodospirillum.

For over seven years this balanced culture has maintained itself anærobically without additional food material. The Euglena accumulates in green masses at the base of the cylinder, which is kept in the light from a window, at laboratory temperature. It flourishes abundantly in summer, feeding on the Rhodospirillum and carrying on photosynthesis until the organisms are filled with rounded grains of paramylum, a carbohydrate closely related to starch, but which remains colourless with iodine solution.

When filled with paramylum grains, the cells encyst and become quiescent. They are then attacked by the Rhodospirillum, one of the sulphur bacteria having a spiral, flagellated cell.

Under the microscope, numerous cells of Rhodospirillum can be seen attacking each of the cysts of Euglena and destroying the contents. During the winter, when sunlight is at a minimum, the Rhodospirillum flourishes, and the water in the upper part of the cylinder is deep red with them, but no spore formation has been observed.

This balanced condition, in which each organism feeds on the other in one stage of its existence, has maintained itself without alteration for seven years. The Euglena obtains a certain amount of energy from the sunlight, and both organisms may feed to some extent on the remains of the hay infusion. They are living without air, and this balanced type of enforced metabolic symbiosis can apparently be continued indefinitely. From time to time considerable quantities

of Euglena have been removed from the cylinder for class purposes, and probably, as a result, it is relatively less abundant than formerly. The layer of heavy oil over the water was found to oxidise slowly, and has been replaced by medicinal paraffin, a hydrocarbon which is free from oxidation. Attempts to cultivate this Euglena have not been so successful as they are when the organisms are obtained from other (ærobic) sources, and it is possible that the Euglena has lost vitality through living for a long period anærobically.

A vote of thanks was accorded to Prof. Gates for his exhibit.

Papers.—The following communications were read and discussed :—

Mr. S. C. Akehurst, F.R.M.S.—

"Observations on Pond Life, with Special Reference to the possible Causation of Swarming of Phytoplankton."

Mr. J. M. Preston, B.Sc., A.I.C., F.R.M.S.—

"A New Top Light Illuminator." (Communicated by Dr. Tierney.)

Votes of thanks were accorded to the authors of the foregoing communications and to Messrs. Flatters & Garnett, Ltd., for the loan of instruments illustrating Mr. Preston's paper.

Announcements.—The President made the following announcements :—

The Rooms of the Society will be closed from December 23rd to 29th, 1930.

The Biological Section will meet in the Pillar Room at 6 p.m. on Wednesday, January 7th, 1931.

The Annual General Meeting of the Society will be held on Wednesday, January 21st, 1931, when Prof. R. Ruggles Gates, M.A., Ph.D., LL.D., will deliver the Presidential Address.

The proceedings then terminated.

THE ANNUAL MEETING.

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, JANUARY 21ST, 1931, PROF. R. RUGGLES GATES, M.A., PH.D., LL.D., F.L.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

James Henry Dible, M.B., Ch.B., F.R.C.P., Liverpool.
Edward Charles T. Holsinger, Ceylon.
Frank Humphrys Lewis, Reading.
A. E. C. Smith, M.A., A.I.C., Southampton.

Signing the Roll.—The following gentlemen present having subscribed their Signatures to the Roll, were received by the President, and formally admitted to the Fellowship of the Society :—

Mr. George Frederick Bates.
Dr. Lionel Percy Clarke.
Mr. Ivor Vickery Newman.

The Nomination Certificate, in favour of the following candidate, was read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

Alec William Haggis, Wembley.

Donations were reported from :—

Oxford University Press—
" Early Theories of Sexual Generation." By F. J. Cole.

Mr. Elliot Stock—
" A Biographical Sketch of Francis James Blight, F.R.S.E., Publisher." By George Hawker.

Votes of thanks were accorded to the donors.

Deaths were reported of :—

Lady Catherine Crisp. Elected 1884.
Lieut.-Col. A. C. Robinson. Elected 1924.

Votes of condolence with the relatives were passed.

The Annual Report of the Council for the year 1930 was read as follows :—

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1930.

The Council conveyed a message of loyal congratulation to the King upon the attainment of the twentieth anniversary of his accession to the throne, and received His Majesty's gracious acknowledgment.

PREMISES.

Since the last Annual Meeting the Council reports with pleasure and satisfaction the acquisition of new and desirable accommodation at the British Medical Association House, Tavistock Square, London, W.C. 1, with security of tenure for a number of years. In these new premises the Library and Historical Collections will be more adequately housed, as well as the Society's offices and meeting rooms, and in its new surroundings the Council is assured that the long and honoured traditions of the Society as a learned body will continue to be well maintained.

FELLOWS.

Two Honorary Fellows and twenty-six Ordinary Fellows have been elected during the year, and one has been reinstated.

The Council has had to deplore the loss of nine Ordinary Fellows by death, while seven have resigned, and seven have been removed from the Roll under By-Law 31.

The deaths reported are as follows :—

T. S. Adair. Elected 1893.
H. C. Batchelor. Elected 1924.
Thomas Castle. Elected 1927.
Colonel J. W. Gifford. Elected 1892.
John Macintyre. Elected 1894.
Jacob Pillischer. Elected 1898.
E. A. Pinchin. Elected 1911.
Edmund Warner. Elected 1885.
B. B. Woodward. Elected 1880.

JOURNAL.

In addition to several important monographs published in the Society's Journal during the year, the number of original communications on microscopical technique and manipulation, as well as descriptions of new instruments and apparatus, shows a notable increase, while the extensive series of abstracts of current English and foreign literature in microscopic botany, zoology, and applied microscopy continues to be well maintained.

The list of subscribers to the Journal shows a further increase, and its worldwide circulation continues.

Dr. G. M. Findlay has rendered valued service to the Society as Honorary Editor during the year, and the thanks of the Fellows are due to him and to the Editorial Committee and Panel of Abstractors for their continued assistance.

LIBRARY.

With the more adequate accommodation for the Society's Library in its new premises, and as a result of the cordial co-operation existing between the Society and the National Central Library (formerly known as the Central Library for Students), the Society's Library continues to be of increasing usefulness and importance.

Exclusive of the volumes referred to by Fellows and visitors to the Library, the number borrowed during the year is 152, of which 10 were loaned to the National Central Library.

Donations to the Library have been received from Messrs. Edward Arnold & Co.; Trustees of the British Museum; The Century Co.; Department of Scientific and Industrial Research; Mr. W. N. Ellis; Dr. G. M. Findlay; MM. Gaston Doin & Cie.; Prof. R. Ruggles Gates; Messrs. Walter de Gruyter & Co.; Mr. Chas. E. Heath; Mr. N. Ingram Hendey; Mr. H. S. Jennings; Prof. S. R. Kashyap; Messrs. Longmans, Green & Co.; Messrs. McGraw Hill Publishing Co.; Mr. Thomas R. Maynard; Medical Research Council; Natural History Society of Northumberland, Durham & Newcastle-upon-Tyne; Oxford University Press; Prof. M. von Rohr; Messrs. Sidgwick & Jackson; Société Hollandaise des Sciences de Harlem; H.M. Stationery Office; Prof. L. H. Tiffany; and Prof. Hans de Winiwarter.

A valuable accession to the Library has also been received from Mr. C. D. Soar, in a collection of publications on the Hydracarina, by various authors.

The Society is greatly indebted to Prof. F. J. Cheshire for presenting a collection of the original letters of Abbe to Stephenson, 1875–1886.

In addition to the foregoing, the Society is also indebted to Mr. J. Rheinberg for editing and presenting a set of photographic reproductions of the above Abbe letters.

Through the generous assistance of the Carnegie Trustees, which the Council gratefully acknowledges, a considerable number of accessions have been added to the Library during the year, a supplementary catalogue of which will be published in due course.

The reindexing of the Library consequent upon removal is a slow and arduous task, which it is hoped will be accomplished without undue delay. Meanwhile, books required to be borrowed take rather more time to find than normally.

INSTRUMENTS AND APPARATUS.

The Curator of Instruments reports that the following accessions to the Society's Collection have been received during the past year:—

Dr. Peyton T. B. Beale—

A Portable Microscope and Accessories by Swift, *c.* 1878.

Dr. E. W. Bowell—

A Zeiss Aspherical Projection Condenser and Stand.

Dr. L. P. Clarke—

A Lucernal Projection Microscope by Apps.

Mr. R. Maxwell—

A Double Reflecting Microscope of the Culpeper Type, *c.* 1740 (donated on loan).

Prof. A. Gandolfi Hornyold—

A Zeiss Microscope in Case.

The latter is a welcome accession to the instruments available for use at the Society's meetings.

Through the kindness of Mr. Barnard, the Society's optical bench equipment has been thoroughly overhauled and reconditioned, and the Council has authorised the purchase of a new arc lamp, the present lamp being found unsuitable for the electric mains in the new premises.

Council has also authorised the acquisition of a new projection apparatus for use in the Biological and other sectional meetings.

The removal of the Society's Collection from Hanover Square to the new premises has caused a certain dislocation, but it is hoped that it will now be possible to display a large portion of this unique Collection in a manner worthy of the Society and of the Collection itself.

Certain of the instruments are being cleaned, and necessary adjustments and repairs, both to the instruments and cases, are being carried out, and it is expected that the whole Collection will be available for Members' inspection at an early date.

SLIDE COLLECTION.

The Curator of Slides reports that the Society's Cabinet has been renovated and repolished during the year, and 34 slides have been borrowed therefrom.

The following accessions have been added to the collection :—

Messrs. Flatters & Garnett—

1 Micro Slide of *Pleurosigma terryanum* mounted in Hyrax and in Styrax for comparison.

Mr. G. Dallas Hanna—

A Sample Tube of Hyrax.

Rev. Dingley P. Fuge—

3 Slides of *Navicula alpestris.*

Mr. N. Ingram Hendey—

1 Micro Slide of *Stephanodiscus Nova-Zealandicus,* and a sample of Diatomaceous Earth from Jutland.

Mr. E. Heron-Allen and Mr. Arthur Earland—

5 Paratype Slides of *Miliammina:* a New Siliceous Genus of Foraminifera.

A Collection of Micro Slides of Freshwater Rhizopoda.

Mrs. E. T. Newton—

117 Micro Slides from the Collection of the late Mr. E. T. Newton, F.R.S.

MEETINGS.

Eight Council Meetings, eight Ordinary Meetings, and one Special General Meeting have been held during the year, and the attendance has been good.

A meeting was held in May in the Great Hall at King's College, Strand, for the special consideration of recent advances in microscopic metallography. The meeting was accompanied by a comprehensive exhibition and demonstration of instruments and apparatus, and several important communications were delivered, which have been published in the Society's Journal.

The Council is glad to report that consequent upon the change of address, and at the request of the Fellows, it has been found convenient to hold the Ordinary Meetings at 5.30 p.m., preceded by tea at 5 o'clock, thus affording country members an opportunity of attending. The change was effected with the opening of the present session, and the meetings have been well attended.

The Council conveyed its congratulations to Prof. J. Arthur Thomson (Past President), upon his receiving the honour of knighthood from His Majesty the King.

The Society was represented by Dr. Tierney at a conference convened by the Association of Scientific Workers to consider the financial provisions made for the Science Library, South Kensington. A committee was appointed to consult with the Director of the Science Museum and to approach the President of the Board of Education thereon.

The Council appointed Mr. D. J. Scourfield and Dr. C. Tierney to represent the Society at a conference held at the Fishmongers' Hall, London, in February last, under the auspices of the Freshwater Biological Association of the British Empire, to consider the establishment of a freshwater biological laboratory in Britain.

Plymouth Table.—The use of the Society's table at the Marine Biological Laboratory, Plymouth, was granted to Prof. H. Graham Cannon from March 31 to April 29 last.

Miss C. W. Simpson has continued to render loyal and noteworthy service throughout a strenuous and exacting year.

The thanks of the Society are due and are hereby conveyed to the following firms who have kindly loaned instruments and apparatus for use at its meetings and demonstrations during the year :—Messrs. R. & J. Beck, Ltd. ; Messrs. Flatters & Garnett, Ltd. ; Messrs. Chas. Hearson & Co., Ltd. ; Messrs. Adam Hilger, Ltd. ; Messrs. E. Leitz (London) ; Messrs. James Swift & Son, Ltd. ; Messrs. Vickers-Armstrongs, Ltd. ; Messrs. W. Watson & Sons, Ltd. ; and Messrs. Carl Zeiss (London), Ltd.

BIOLOGICAL SECTION.

The Secretary of the Biological Section reports that the number of short communications and the interest of their subjects have been well maintained during the year, but there have not been quite so many general exhibits as could have been wished. The attendance has been good, and in addition to the ordinary meetings of the Section, visits have been paid to the laboratories, etc., of the Pharmaceutical Society and the London School of Hygiene and Tropical Medicine. The best thanks of the Section are due to the authorities of those institutions, and in particular to Prof. Greenish and Prof. Leiper respectively, for the trouble taken to make the visits so interesting and instructive. With the change in the place of meeting to the B.M.A. House, the time of meeting of the Section was altered to 6 o'clock.

It was unanimously resolved, on the motion of Mr. J. T. Holder, seconded by Mr. G. T. Gurr :—

"That the Annual Report be received and adopted."

The following resolution, moved by Mr. Joseph Wilson, and seconded by Mr. A. W. Sheppard, was carried with acclamation :—

"That a very hearty vote of thanks be tendered to the Officers and Members of the Council for their services during the past year."

Mr. C. F. Hill and Dr. C. Tierney responded.

THE ELECTION OF OFFICERS AND MEMBERS OF COUNCIL.

The President appointed Mr. C. H. Oakden and Mr. J. Richardson to act as scrutineers, and afterwards declared the result of the ballot for the election of Officers and Members of the Council for the ensuing year as follows :—

President.—R. Ruggles Gates, M.A., Ph.D., LL.D., F.L.S.

Vice-Presidents.—F. W. Rogers Brambell, B.A., D.Sc., Ph.D. ; W. E. Cooke, M.D., F.R.C.P., D.P.H. ; A. Earland ; J. Rheinberg, F.Inst.P.

Treasurer.—Cyril F. Hill, M.Inst.M.M., A.Inst.P.

Secretaries.—J. E. Barnard, F.R.S., F.Inst.P. ; Clarence Tierney, D.Sc., F.L.S.

Ordinary Members of Council.—W. A. F. Balfour-Browne, M.A., F.R.S.E., F.Z.S., F.E.S. ; C. Beck, C.B.E., F.Inst.P. ; E. W. Bowell, M.A., M.R.C.S., L.R.C.P. ; G. R. Bullock-Webster, M.A., F.L.S. ; G. M. Findlay, O.B.E., M.D., D.Sc. ; R. T. Hewlett, M.D., F.R.C.P., D.P.H. ; J. E. McCartney, M.D., Ch.B., D.Sc. ; Doris L. Mackinnon, D.Sc., F.L.S. ; J. H. Pledge ; G. S. Sansom, D.Sc. ; D. J. Scourfield, I.S.O., F.L.S., F.Z.S. ; E. J. Sheppard.

Librarian.—Clarence Tierney, D.Sc., F.L.S.

Curator of Instruments.—W. E. Watson Baker, A.Inst.P.

Curator of Slides.—E. J. Sheppard.

On the motion of the President, a vote of thanks was accorded to the scrutineers.

Presidential Address.—Prof. R. Ruggles Gates then delivered his Presidential Address on :—

"Adaptations in Cell Structure."

Dr. E. W. Bowell moved : "That the best thanks of this meeting be accorded to Prof. R. Ruggles Gates for his Presidential Address, and that he be asked to allow it to be printed in the Journal of the Society."

Prof. R. T. Hewlett seconded the proposal, which was carried with acclamation.

Prof. Gates responded.

Announcement.—The President announced that the Biological Section would meet in the Pillar Room on Wednesday, February 4th, 1931, at 5 p.m.

The proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, FEBRUARY 18TH, 1931, PROF. R. RUGGLES GATES, M.A., Ph.D., LL.D., F.L.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellow.—The following candidate was balloted for and duly elected an Ordinary Fellow of the Society :—

Alec William Haggis, Wembley.

Nomination Certificates in favour of the following candidates were read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

Dheenath Sitanath Ajinkya, Bombay.
Abel Prescott Bradshaw, Manchester.
John Clegg, Southport.
Pieter Cornelis Jansen, The Hague.

Donations were reported from :—

Prof. A. Gandolfi Hornyold, D.Sc., F.R.M.S.—
Six pounds ten shillings.

Mr. F. J. Myers, F.R.M.S.—
"The Rotifer Fauna of Wisconsin," Parts I, III, IV and V. By H. K. Harring and F. J. Myers.
A Collection of Slides of the Rotifera.

Votes of thanks were accorded to the donors.

Deaths were reported of :—

J. B. Fleuret. Elected 1919.
Herbert Sutcliffe. Elected 1918.

Votes of condolence with the relatives were passed.

Papers.—Dr. Robert Chambers, Professor of Biology, Washington Square College, University of New York, then delivered an address on "The Nature of the Living Cell," with demonstration by micro-dissection, micro-injection and cinematograph.

Prof. Chambers observed that probably the most striking peculiarity of living matter, or protoplasm, is the fact that it exists only within the confines of microscopic dimensions. Protoplasm is protoplasm only in the form of living cells, plant or animal; therefore the only direct method of studying its properties is through the compound microscope under magnifications varying from 150 to over 1,000 diameters.

The micro-dissection and micro-injection technique of Prof. Chambers was evolved in order to make it possible to manipulate the protoplasm within the living cell. The apparatus is a mechanical device for controlling the movements of glass-spun micro-needles and pipettes within the field of the microscope. An apparatus of this kind, built in 1920, was first demonstrated before the Royal

Microscopical Society about six years ago. Since then several different types of instrument have been developed by various workers. The present apparatus is a model based upon the original one of 1920, but has been modified from year to year by the addition of various improvements, and is so constructed as to permit operations upon the living cell under the highest magnifications.

By means of this instrument a great many new facts have been discovered regarding the physical and chemical properties of protoplasm. We now know, for instance, that the nucleus in many cells is a fluid body and is more alkaline in reaction than the cytoplasm in which it is immersed. The oxidation intensity of living protoplasm has also been determined by the injection into the living cell of dyes which are reducible. For example, when the colour disappears upon injection and can subsequently be made to reappear by the injection of an oxidizing agent, we can be fairly certain that the protoplasm has reduced it in the first instance. Similarly, by this method, the physical properties of the hitherto hypothetically regarded cell-membrane have been made the object of intensive study.

On the motion of the President, a very hearty vote of thanks was accorded to Prof. Chambers for his communication and demonstration, and to Messrs. E. Leitz (London) for the loan of instruments for the Meeting.

The following papers were read in title :—

Dr. W. E. Cooke, M.D., F.R.C.P., D.P.H., F.R.M.S., and Mr. C. F. Hill, M.Inst.M.M., A.Inst.P., F.R.M.S.—

"Microscopical Studies in Pernicious Anæmia. II.—The Hæmoglobiniferous Cells (contd.): The Basophilic Conditions found in Erythrocytes."

Mr. L. La Cour—

"Improvements in Everyday Technique in Plant Cytology."

Prof. A. Gandolfi Hornyold, D.Sc., F.R.M.S.—

"On the Preparation of Eel Scales."

Mr. George C. McLennan—

"A Paraffin Embedding Apparatus."

Announcement.—The President announced that the Biological Section would meet in the Pillar Room on Wednesday, March 4th, 1931, at 6 p.m.

The proceedings then terminated.

// JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1931.

TRANSACTIONS OF THE SOCIETY.

V.—MICROSCOPICAL STUDIES IN PERNICIOUS ANÆMIA. III. 612.111.6.

By W. E. Cooke, M.D., F.R.C.P.E., D.P.H., and
C. F. Hill, M.Inst.M.M., A.Inst.P., F.R.M.S.

(*Read March* 18, 1931.)

Two Plates.

The Macropolycyte.

Variations in the neutrophil polymorphonuclear leucocyte are a constant feature in pernicious anæmia. The average diameter of normal polymorphs in fixed and stained films is 12 microns. In pernicious anæmia small forms, which may be termed micropolycytes, are frequently encountered (pl. IX, fig. 1). These cells measure 10 microns or less in diameter, and the nuclei may be single or have two, three, four or five segments, as in the normal state. The nucleus, on the other hand, may be hypersegmented—a common finding in pernicious anæmia in polymorphs of normal size. This hypersegmentation of the nucleus in cells of normal size is illustrated by figs. 2, 3, 4, 5, 6, 7 and 8, in pl. IX.

From the micropolycyte all gradations occur up to the giant polymorph or macropolycyte which measures 16 to 20 or more microns in diameter. The type 1 macropolycyte resembles the other polymorphs in the film in

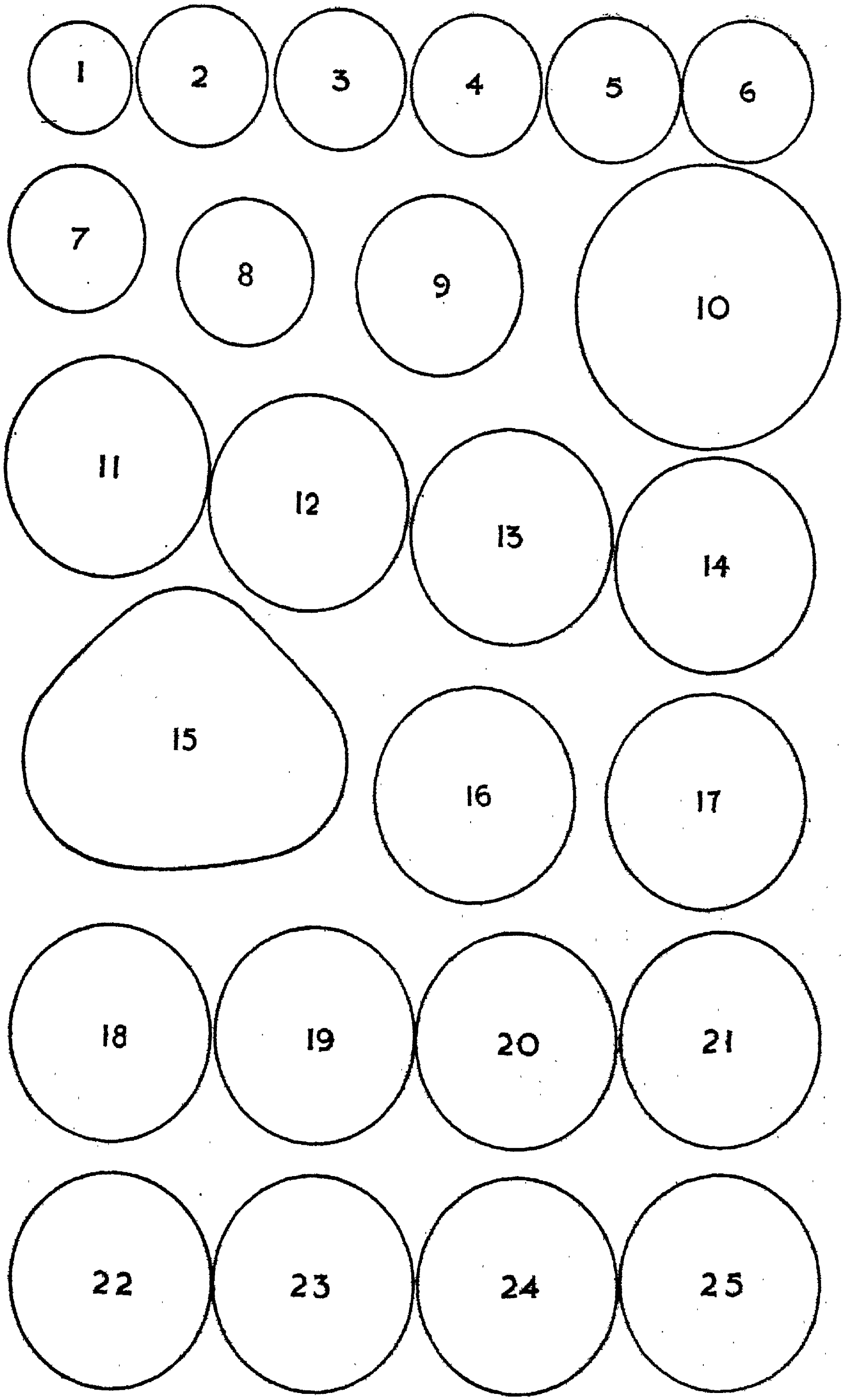
nuclear structure and the staining reaction of its granules. These are oxyphil. It differs only in size and in that its nucleus frequently shows very marked hypersegmentation. Figs. 9, 10, 11, 12, 13 and 14, pl. IX, illustrate this cell. There are several possible explanations of these abnormal cells. The polymorph in health emerges from the marrow with a single-lobed nucleus, and as it grows older in the blood stream its nucleus segments into two, three, four, and finally five portions. It is very rare to see a cell with more than five nuclear segments in health. The polymorphs of normal size with hypersegmented nuclei may be due to some alteration in the plasma that prematurely ages the polymorph and alters its life-history. The second explanation may be that the mechanism for the elimination of aged polymorphs is in abeyance; the third theory, that the polymorph is inherently abnormal owing to a defect in its parent—the hæmocytoblast.

Probably there is a single biochemical defect which accounts for all these conditions, because, after a few days on a liver diet or on ventriculin, macropolycytes and polymorphs with hypersegmented nuclei disappear and are replaced by morphologically normal cells.

The second type of macropolycyte resembles in some respects the megakaryocyte of the marrow. It is a large cell measuring up to 24 microns in diameter. The nucleus is gnarled and may be of a simple horseshoe type or may have 10 or more segments. The granules in the cytoplasm are coarse, and in staining reaction mixed, both oxyphil and azurophil granules being present. It is not, however, an accurate replica of the megakaryocytes of the marrow. It may have its origin in the marrow and be an expression of the abnormal reversion to embryonic type, as are the hæmoglobiniferous cells. On the other hand, the cell may arise from the mesenchyme descendants in the liver and hæmolymph glands that have undergone abnormal myeloid metaplasia. They are found in the liver and pre-aortic glands in association with islets of megaloblasts.

There is a third type of macropolycyte. This cell has features of both the preceding types. It resembles the type 1 cell in having fine oxyphil granules in its cytoplasm, whilst the general nuclear conformation is that of the megakaryocyte type. The 12 figs. on pl. X illustrate this cell. It differs from both in nuclear structure. As the illustrations show, the structure is a very open meshwork, suggesting a deficiency in basi-chromatin. The bulk of the nucleus appears to be large in comparison with the cytoplasm, and we have not seen hypersegmentation in this type of cell. We believe it is a variant of the megakaryocyte type, and the explanation of its presence in the blood stream to be the same.

None of the macropolycytes has a counterpart in either embryonic or post-natal hæmopoietic tissues or the blood stream.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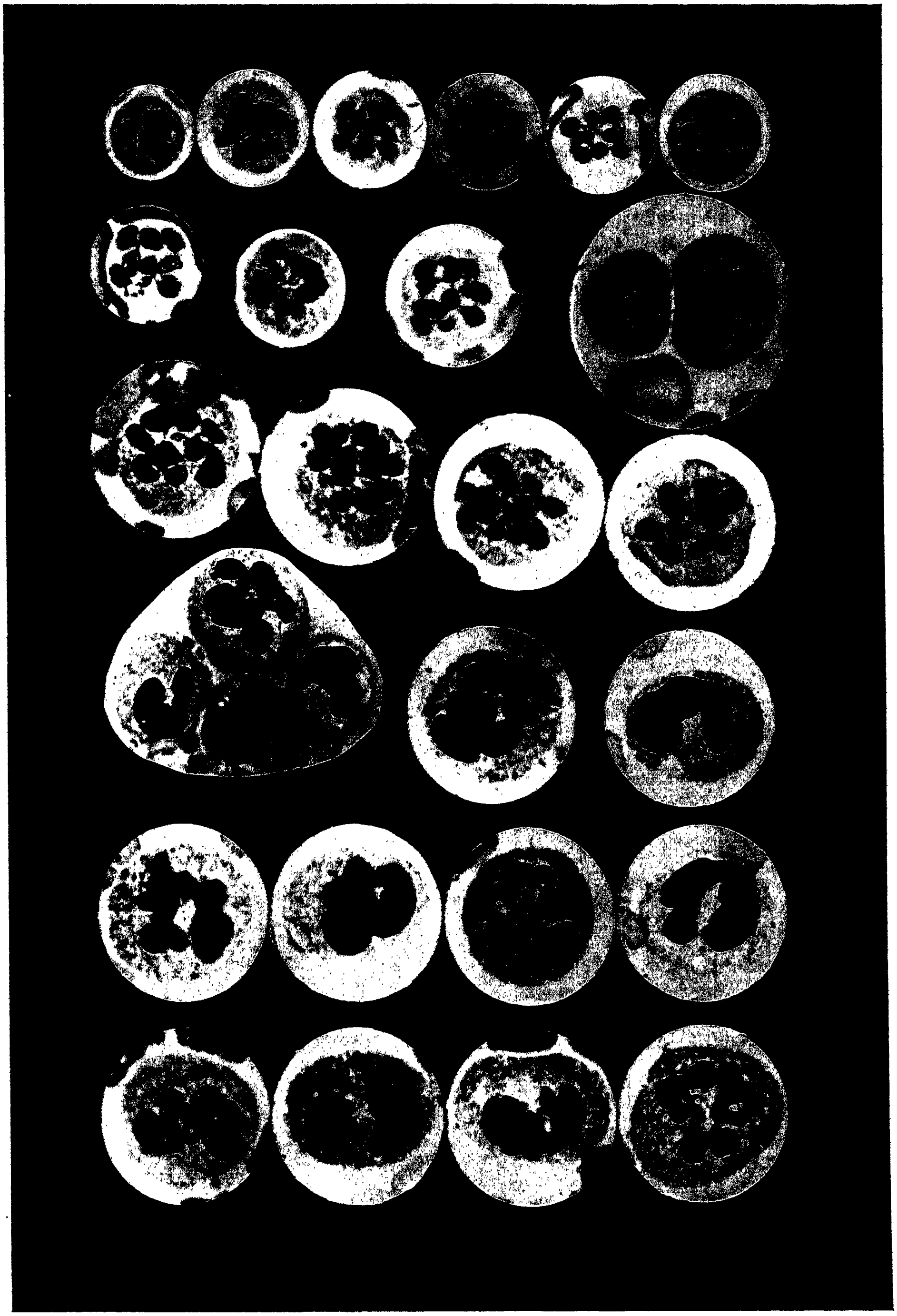

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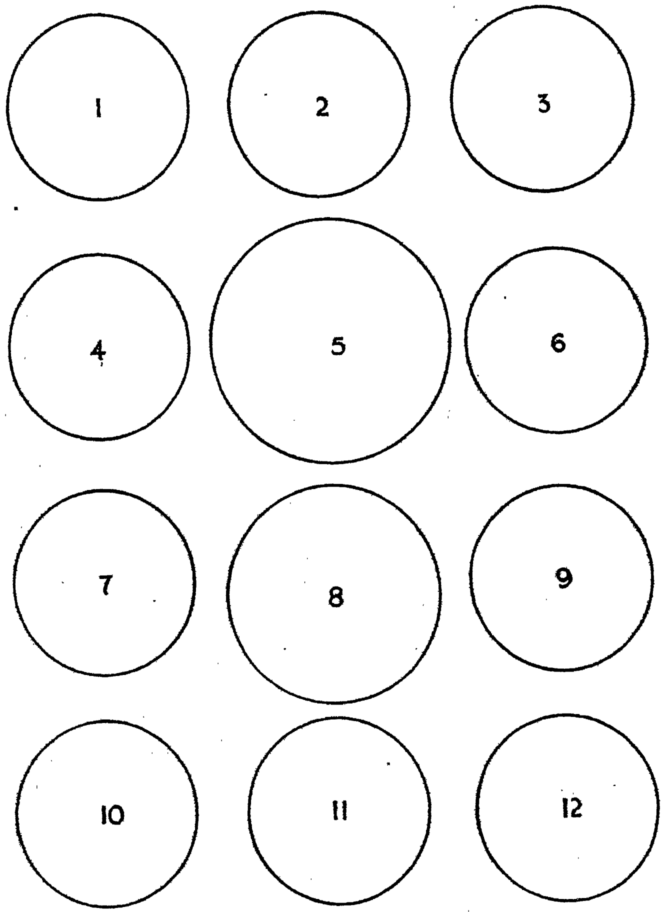
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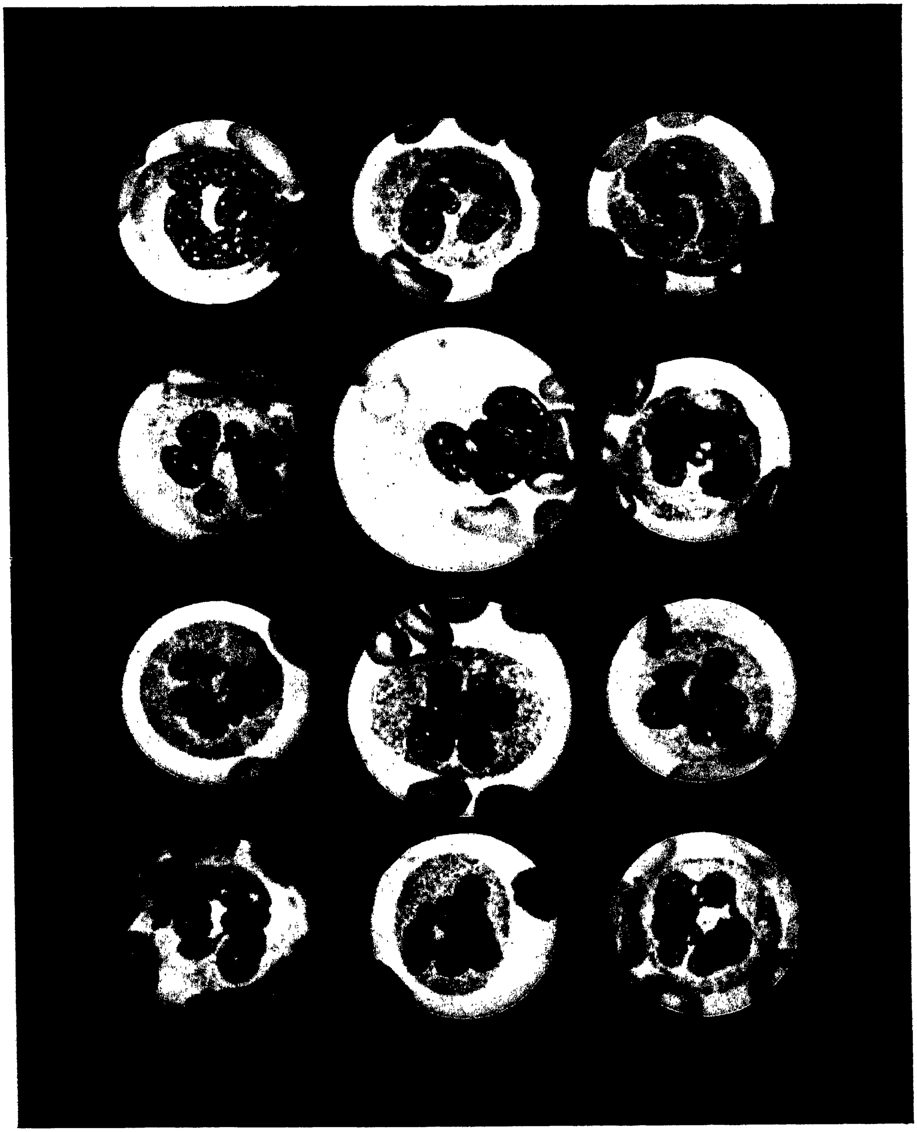


DESCRIPTION OF PLATES.

PLATE IX.

Fig. 1.—A polymorph of small size—a micropolycyte.

Figs. 2, 3, 4, 5, 6, 7 and 8.—Polymorphs of normal size showing hypersegmentation of the nucleus.

Figs. 9, 10, 11, 12, 13 and 14.—Macropolycytes of type 1.

Figs. 15 to 25.—Macropolycytes of the megakaryocyte type.

× 1,000 diameters.

PLATE X.

Figs. 1 to 12 illustrate the third type of macropolycyte. The figures show the large bulk of the nucleus, the structure of which appears to be a more open meshwork than normal, suggesting deficiency in basi-chromatin. The fine cytoplasmic oxyphil granules are also seen.

× 1,000 diameters.

612.111.6. VI.—MICROSCOPICAL STUDIES IN PERNICIOUS ANÆMIA. IV.

By W. E. Cooke, M.D., F.R.C.P.E., D.P.H., and
C. F. Hill, M.Inst.M.M., A.Inst.P., F.R.M.S.

(*Read March* 18, 1931.)

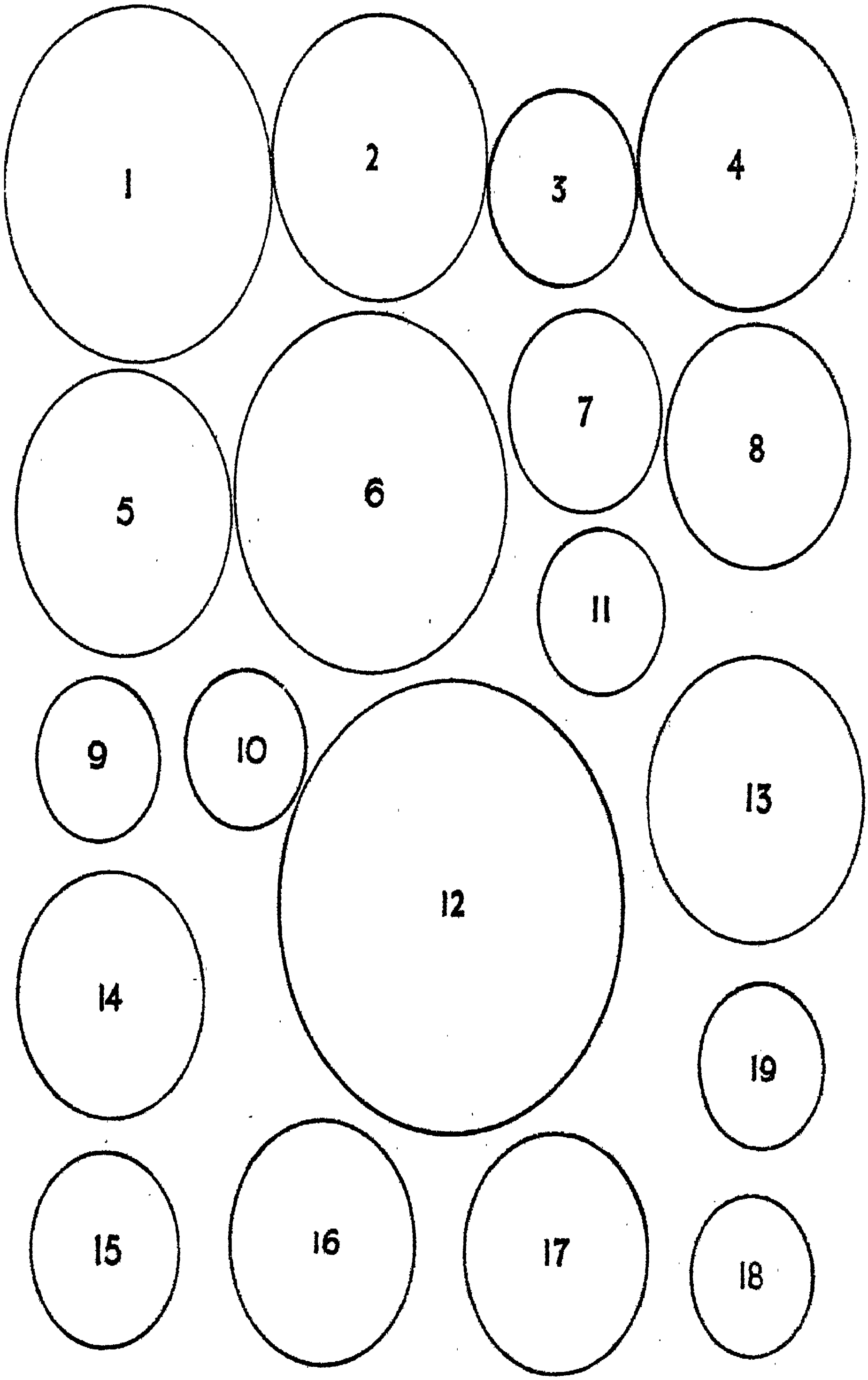
One Plate.

Nuclear Degeneration in Blood Stream Cells.

This remarkable phenomenon, to which we cannot find any reference in cytological or hæmatological literature, occurs in certain cases of pernicious anæmia. The degeneration of the nucleus occurs in megaloblasts, polymorphs, and lymphocytes; only rarely have we seen it in eosinophils, probably because these cells seem to be very scanty in the cases in which nucleus degeneration occurs. The first observable change in the process of degeneration is the loss of structure in small areas of the nucleus. The basi-chromatin in these areas loses the reddish-purple colour with azur-eosin stains and takes on a pinkish-red appearance. These areas extend and the staining reaction becomes paler and paler until the nucleus becomes a structureless pinkish or dirty white mass. The cell body remains intact until the final stages.

Fig. 1, pl. XI, illustrates the usual appearances of a polymorph, lymphocyte, and a megaloblast.

Normally the early signs of death of the polymorph as seen in the blood-stream are rupture of the cell membrane and, coincidentally, loss of the fine chromatin filaments connecting the nuclear segments. This is seen in figs. 2 and 3, pl. XI. The cells illustrated are old polymorphs, as evidenced by the number of their nuclear segments. They are class V cells. The cell membrane has ruptured and the cytoplasmic contents escaped. The fine chromatin filaments between the nuclear segments have almost all disappeared. There are two remaining in fig. 3. The nuclear structure, although somewhat blurred, is still discernible. The staining reaction of the basi-chromatin is becoming red instead of the deep reddish-purple of the living cell. The cell on the right in fig. 4 shows both the normal death and nuclear degeneration commencing in the light areas of the nucleus.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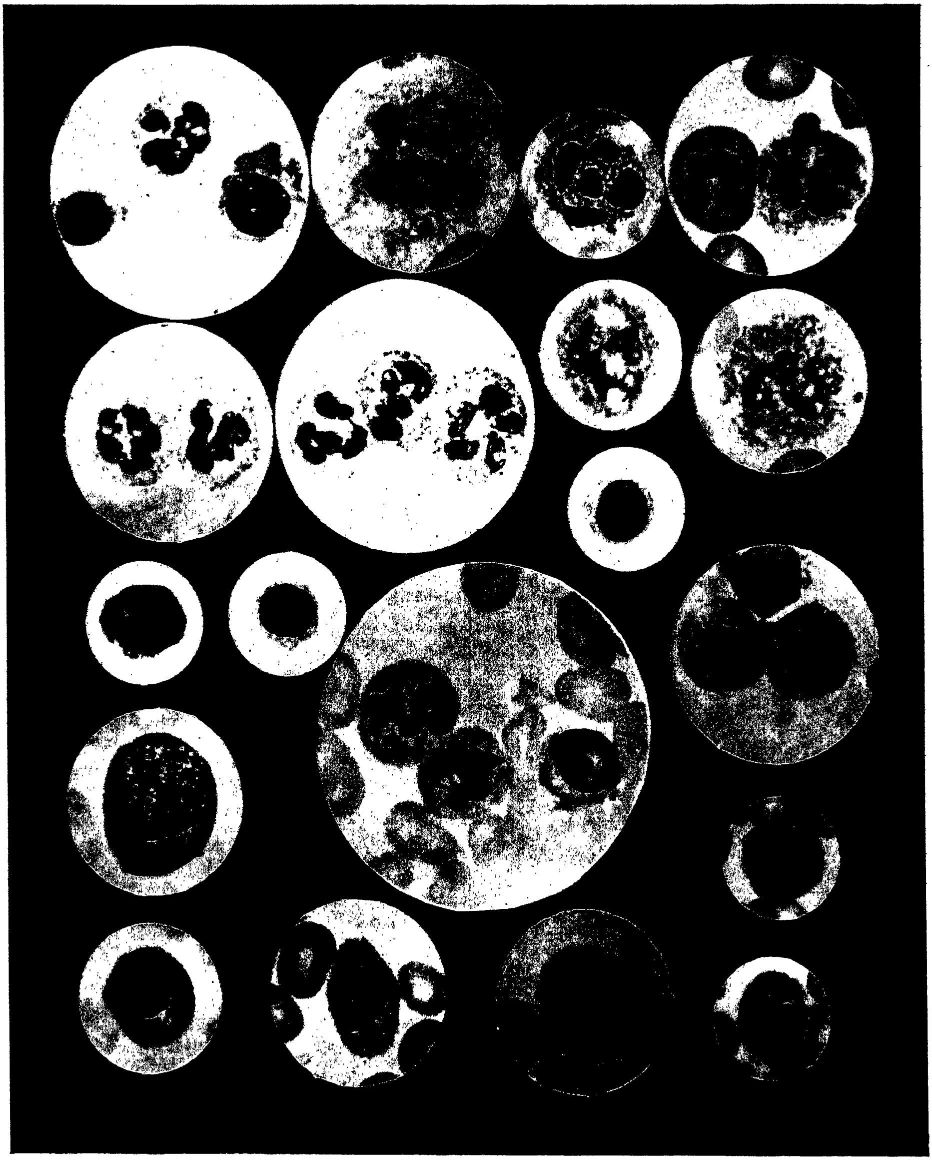

It will be noticed that the cell outline is indistinct and part of the nucleus protruding.

In fig. 5 the cell on the left is a normal polymorph. That on the right shows fairly early nuclear degeneration, with the cell body intact. In fig. 6 the left-hand cell is normal, but the two cells on the right show different stages of degeneration of the nucleus. Here, again, the cell membrane appears intact. The cell in fig. 7 illustrates a late stage in nuclear degeneration in the polymorph. Even at this late stage disperson of the cytoplasm has not taken place to any extent, and the outline of the body is still visible.

Fig. 8 is an example of nuclear degeneration with definite loss of the cell membrane.

The normal termination of the lymphocyte takes place in much the same manner as in the polymorph. The cell membrane and the cytoplasm are lost early, nuclear structure becomes invisible, and the nucleus stains uniformly a dull red.

Fig. 9, pl. XI, illustrates a lymphocyte that has lost its cell body and whose nucleus is undergoing disintegration.

Figs. 10 and 11 are examples of early nuclear degeneration in lymphocytes. The lymphocyte in fig. 12 shows a later stage and the cells in fig. 13 the last stage in cells which still retain their contour and whose cytoplasms appear intact. In this stage the nucleus appears quite structureless, and the pale areas in the photomicrograph are pale pink or a dirty white and the dark areas a reddish-pink. The colours merge from the outer reddish-pink zone through pale pink to white.

The megaloblast nucleus normally undergoes the changes described in paper I, and finally disappears, leaving the non-nucleated megalocyte.

In some cases of pernicious anæmia nuclear degeneration and death take place.

Fig. 14 illustrates early degeneration in a megaloblast of the first generation.

Figs. 15, 16, 17, 18 and 19 show the degeneration in various stages in second generation cells. The same changes we have described in the lymphocyte and polymorph take place. The final stages are seen in figs. 17, 18 and 19.

We cannot at present give any explanation of this nuclear degeneration in blood stream cells. It appears to affect the marrow and lymphoid cells indiscriminately, but we have not seen it in monocytes.

DESCRIPTION OF PLATE.

PLATE XI.

Fig. 1.—The cell on the left is a lymphocyte. The cell above is a polymorph, and on the right is a megaloblast.
Figs. 2 and 3 illustrate the normal death of polymorphs as seen in the blood stream.
Fig. 4.—On the left is a normal polymorph. The right-hand cell shows loss of the cell membrane and early nuclear degeneration.
Fig. 5.—The cell on the left is a normal polymorph, that on the right a polymorph whose nucleus shows early degeneration.
Fig. 6.—The cell on the left is a normal polymorph. The two polymorphs on the right of it show nuclear degeneration with apparently intact cytoplasm.
Fig. 7 illustrates a late stge of nuclear degeneration in the polymorph.
Fig. 8 illustrates a polymorph whose cell membrane has been lost and whose nucleus shows areas of degeneration.
Fig. 9 illustrates the normal death of the lymphocyte in the blood stream.
Figs. 10, 11, 12 and 13 illustrate the various stages of nuclear degeneration in lymphocytes.
Fig. 14 illustrates early nuclear degeneration in a megaloblast at the first generation.
Figs. 15, 16, 17, 18 and 19 illustrate nuclear degeneration in megaloblasts of the second generation.

× 1,000 diameters.

VII.—A NEW TOP LIGHT ILLUMINATOR. 535.89

By J. M. Preston, B.Sc., A.I.C., F.R.M.S.

(*Communicated by Dr. C. Tierney, December* 17, 1930.)

Three Plates and One Text-Figure.

When investigating the appearance of opaque or semi-opaque objects, some form of illuminating apparatus is required that will throw light down on the object from above. This in the case of high-power microscopy, where only a small area of the object needs illumination, is comparatively simple, since there are several fairly satisfactory types of illuminator avilable. Of these, the Beck or Nachet type vertical illuminators are the best known, though these suffer from a defect which manifests itself when examining irregular surfaces, in that there is very little relief or " plasticity " shown—in other words, there is a false appearance of flatness. A much better rendering of relief in the case of irregular surfaces is obtained by the ring illuminators of C. and H. C. Beck (E.P. 201,414), and of W. Chapman and R. S. Aldridge (E.P. 215,979), and by the dark-field condenser of F. Hauser (Deut. opt. Woch., 1925, **11**, 185). However, the first and last of these can, unfortunately, only be used with small specimens of about 1 cm. diameter, which cannot be moved far from the central position without obstructing the light that comes from below.

In the fields of low- and medium-power microscopy the illumination must be much more adaptable than in the case of high-power, because of the much greater variety of surfaces that require investigation. It is in this respect that most illuminators fail.

The best-known illuminator, specially designed for low-power work, is the old Lieberkuhn mirror. Though in its original or modified forms it has proved quite useful, yet it has two inherent defects which definitely limit its utility—it can only be used with small specimens, since the light comes from below, and, further, since the light is incident on the surface at a very large angle, there is very little relief shown in the image. The latter defect has, however, been overcome in two illuminators designed respectively by L. A. Jones (Paper Trade Journ., 1926, **55**, 56) and by L. V. Foster (Paper Trade Journ., 1927, **56**, 47), which give illumination whose angle of incidence can be varied between wide limits and produce images in which the degree of relief can be varied at will; yet, like the Lieberkuhn, they can only be used on very small specimens which cannot be moved during the period of observation. However, both the defects of the Lieberkuhn were overcome in the ring illuminator of A. Silverman (Ind. Eng. Chem., 1917, **9**, 971; 1918, **10**, 1013; 1925, **17**, 43), which gives a very " flexible " illumination

readily adaptable to different kinds of surfaces. Unfortunately, this is not obtainable now in this country. In fact, it was the inability to purchase this illuminator which led to the design of the one which is the subject of this communication. Finally, mention should be made of the old silver side-reflector and the parabolic mirror recently described by P. Metzner (Zeit. f. wiss. Mikr., 1929, **46**, 233). These mirrors are very simple and can be quite useful, but of necessity lack adaptability and are difficult to adjust in order to get uniform illumination of the field.

The considerations that are imposed in the design of a suitable illuminator are summarized below :—

1. The illumination must be uniform over a comparatively large field—at least 1·5 cm. in diameter.

2. The angle of incidence of the light upon the object must be variable between wide limits, so that it can be used for both regular and irregular surfaces (L. V. Jones, *loc. cit.*).

3. The illumination, except when specially required, must be from all sides, so that there shall be no azimuth error (P. Metzner, Zeit. f. wiss. Mikr. 1929, **46**, 215).

4. The specimen under examination must not be limited in size, and, further, it must be capable of movement, so as to bring different areas into the field of view.

An illuminator to comply with the above requirements was built to the design of the author by Messrs. Flatters & Garnett, Manchester. It is shown here attached to a monocular microscope in figs. 1 and 2, though it has been used with equally satisfactory results with a Greenough type binocular microscope. This illuminator consists of an annular vulcanite ring whose inside and outside diameters are 8·3 and 12·2 cms. respectively. This is fitted with circular metal bands on both inside and outside, which make contact with twelve small electric lamps of the pocket flashlamp type. The lamps screw into the vulcanite ring from the inside. The inner band makes contact directly, whilst the outer band does so through the agency of small brass screws provided with milled heads, which, incidentally, serve a double purpose in that they also act as individual switches for each bulb. There is thus complete control over the direction of the lighting, whether it shall be from all sides or from one side only, and so on, whilst a plug-and-socket connection enables the illuminator to be quickly attached to an accumulator or other source of electric power.

The vulcanite ring is covered on the top by a thin circular vulcanite disc, which is drilled in the centre to permit observation of the specimen. This disc prevents any direct light from the lamps reaching the eye of the observer.

A slot is cut in the side of the vulcanite ring at the top, which allows a piece of white card to be pushed in so as to act as a reflector. This produces almost vertical illumination by diffuse reflection, and gives illumination

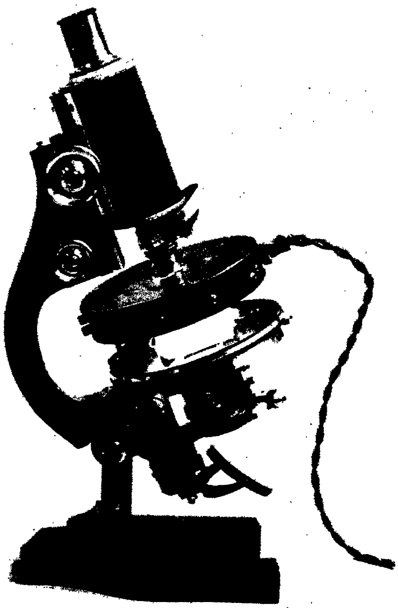

Fig. 1.

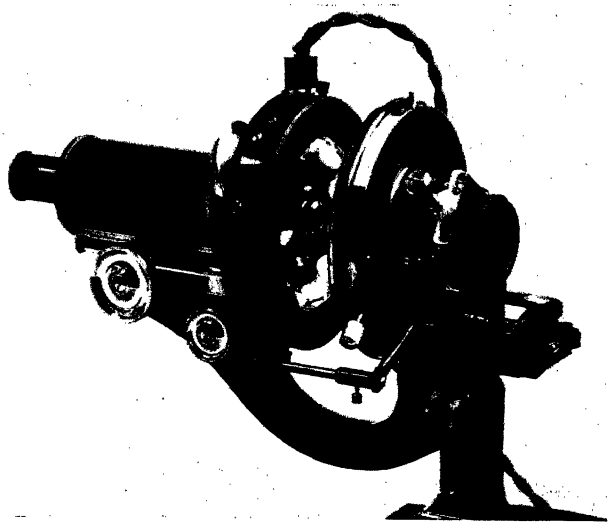

Fig. 2.

Face p. 116.

FIG. 3.

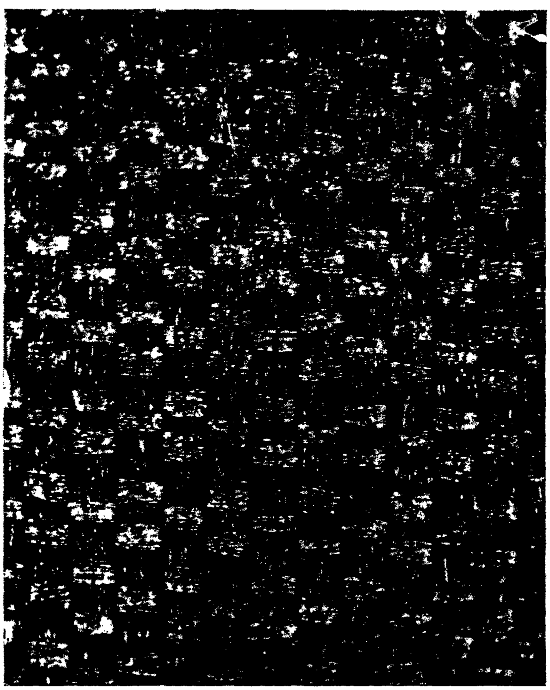

FIG. 4.

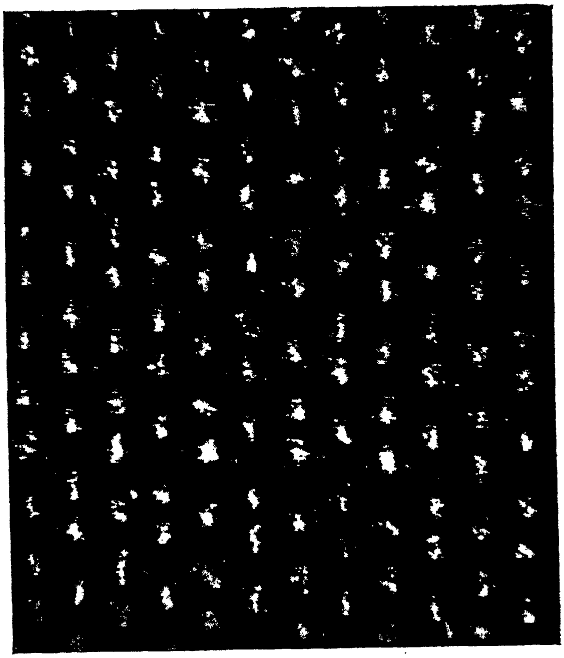

FIG. 5.

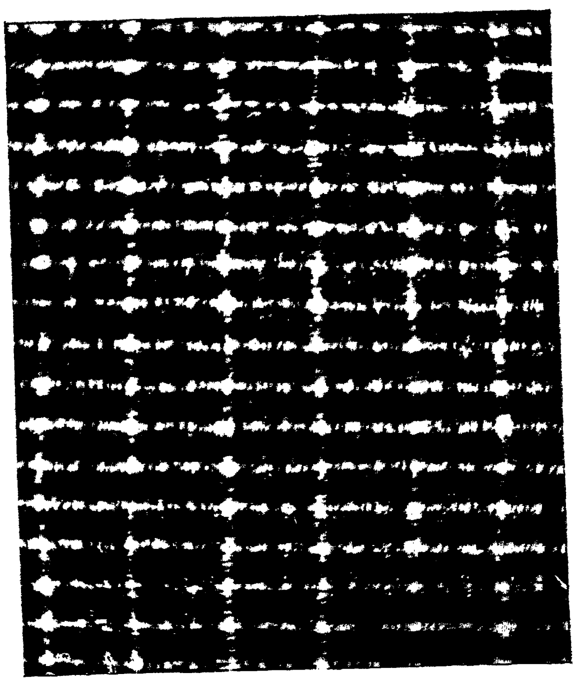

FIG. 6.

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which is very useful on deeply pitted surfaces, since even the deepest parts receive some light without, however, destroying the relief, for the major part of the illumination is still the oblique light received directly from the lamps.

As will be seen in the illustrations, the illuminator is provided with two rod supports, one on each side. These slide into tubular fittings mounted on the top extremities of a steel yoke-piece, where they are clamped in position by two thumbscrews, while the yoke-piece is in turn fastened to the substage by means of a single milled-headed screw, and is prevented from turning sideways by the provision of two small pins which register with corresponding holes in the substage.

This method of mounting the illuminator enables it to be raised or lowered at will by manipulating the substage focusing arrangement. It is thus possible to adjust the illuminator for the optimum angle of incidence of the lighting without interrupting the observation of the object. In addition,

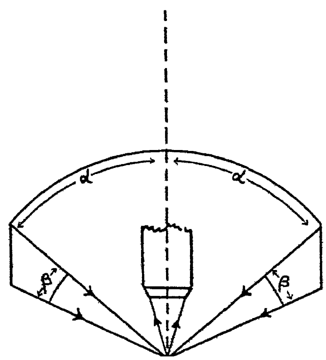


FIG. 7.

it is possible to remove the supports from the illuminator and lay it directly on the specimen.

The illuminator is suitable for objectives from 16 mms. to 100 mms., and has been used for both visual and photographic purposes with excellent results. Photomicrographs taken with a 40 mm. objective at a magnfication of × 20, on rapid panchromatic plates, required about one minute exposure when the illuminator was set for the most oblique lighting and without the use of the white top reflector. However, when the illuminator is raised to give less oblique lighting, or when the white top reflector is introduced, then the exposure is considerably less.

The possibility that the heat of the electric lamps might damage the objective was investigated by placing a thermometer in the position that would be occupied by an objective normally, and the rise in temperature was observed. Initially the temperature recorded was that of the laboratory, which was 10° C., while after five minutes the temperature registered by the thermometer had risen to 17° C., and after one hour to 23° C. Obviously

this rise in temperature is inappreciable and will not do any damage to an objective.

The capabilities of the various illuminators, as far as their ranges of illumination are concerned, are summarized in the table below. The angles refer to fig. 7, where α is the minimum angle of incidence of the lighting relative to the optic axis of the microscope, and β is the range between minimum and maximum angles of incidence of the light in relation to the optic axis. In certain cases these angles can be varied, and in this case the extreme values are indicated. The azimuth range of the lighting refers to the plane of the object, perpendicular to the optic axis, and where this is variable the extreme values are indicated.

Illuminator.	Angle of Illumination Relative to Optic Axis.		Azimuth Range in Plane of Object.
	α	β	
Lieberkuhn Mirror	45°	15°	360°
Beck Aplanatic Ring for 4 mm. objective	51°	18°	360°
Chapman and Aldridge Top Light for 4 mm. objective	58°	14°	360°
Ditto 8 mm. objective	35°	21°	360°
Ditto 16 mm. ,, ...	35°	21°	360°
Hauser Dark-Field Condenser ..	65°	15°	360°
Jones Annular Oblique	85°–60°	5°–30°	360°
Foster	85°–60°	5°–30°	360°
Silverman Ring	85°–30°	5°–12°	360°
Preston Ring	85°–30°	5°–17°	360°–17°
Silver Side-Reflector	45°	35°	180°
Metzner Parabolic Mirror	65°	15°	225°
Busch Oblique Light Condenser ..	55°	30°	45°

In general, the greater is α the more will slight inequalities of the surface be shown up and the greater will be the degree of relief seen in the appearance of the object. This is seen in figs. 3 and 4. Fig. 3 shows a piece of glacé silk fabric illuminated with the author's new illuminator adjusted for the minimum obliquity $\alpha = 30°$, whilst the same fabric is shown in fig. 4 with the illuminator adjusted for the maximum obliquity of lighting $\alpha = 85°$. In addition, the effect of the background is shown in these two photographs, the top in each case being mounted on a white and the bottom on a black background. The lighting as for fig. 4 with dark background is the best for the production of relief, whilst on the other hand, if it had been desired to show up colour differences (if any) and to suppress the relief, then the arrangement of lighting as used for fig. 3 with white background would be the best.

The effect of azimuth error is seen in fig. 5, where the illumination was oblique lighting from one side only (the top as reproduced). It is apparent that an entirely false appearance is given by this mode of lighting. However, it can be used with advantage when it is desired to deliberately exaggerate certain features—in this case the weft threads. The fabric was the same one as shown in figs. 3 and 4, whilst for comparison the same fabric is shown in fig. 6 photographed by transmitted light.

Figs. 3 to 6 were taken at a magnification of $\times$ 41.

VIII.—IMPROVEMENTS IN EVERYDAY TECHNIQUE IN PLANT CYTOLOGY. 578. 65.

By L. La Cour,
John Innes Horticultural Institution, Merton.

(*Read April* 15, 1931.)

Two Plates.

Introduction.

The methods described are those employed at the John Innes Institution. They are not intended to cover the whole field of cytological technique, but to be of use to the student and, perhaps, of interest to the more experienced worker, as some of the methods and fixatives differ a little from those previously published.

It must be realized that perfect fixation of the chromosomes is a prerequisite for their correct description. What is required is a fixative that penetrates quickly, but does not shrink the cytoplasm; that preserves the natural distribution of the chromosomes for counting and gives clear definition of constrictions.

The function of fixing agents is to kill the cell contents of the tissues as rapidly as possible, in order to retain the structure they had when alive. It is also necessary that the material should be sufficiently hardened to preserve it against further change by the action of the reagents with which it may subsequently be treated.

There are three types of fixatives, namely:

1. Vapour.
2. Dehydrating liquid (i.e., alcoholic).
3. Non-dehydrating liquid.

The above are in order of rapidity of fixing. Osmic acid vapour, although used with success for animals, is useless for plants, since the cellulose membranes of plant cells prevent the penetration of the vapour. The alcoholic fixatives dehydrate, and therefore distort, the structure before it is fixed by coagulation. For nuclear material dehydration is preferable after fixation, and should be gradual in order to avoid shrinkage and distortion, which impair the value of the material for critical study.

Therefore, in ordinary practice, the third group alone is satisfactory, except where the epidermis is of a hirsute or waxy nature, in which case the use of an alcoholic fixative is unavoidable.

The hardening process is a gradual chemical change, initiated by the fixative and continued by the 70 p.c. alcohol, in which the material should remain for at least 12 hours.

Fixation of Root-Tips.

Fixatives such as Flemming's and its various modifications are usually best for this purpose. The new fixatives described below give somewhat superior preparations with most plants.

Fresh roots should be taken from a plant that is actively growing. With the aid of a sharp pair of forceps the tips should be removed about ¼ inch from the apex and should be plunged immediately into a phial of fixative (about 7 c.cs.). When enough root-tips have been obtained, the phial should be placed under a vacuum pump for 2 to 3 minutes to remove the air and to aid penetration. If the roots are large, it is best to split them longitudinally.

Fixation of Pollen Mother-Cells.

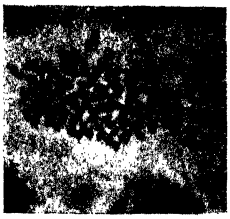
The four chief methods employed in the fixing of pollen mother-cells are :—

1. Belling's aceto-carmine method (Amer. Nat., 1921).
2. Taylor's smear method (Bot. Gaz., 1924, **78**, 236–8).
3. Fixation of anthers in Flemming or other chromic fixatives.
4. Kihara's method (whole buds) (J. Genet., 1928, **20**, 105).

The method of fixing anthers is similar to that described for root-tips. The anthers are dissected out from the buds and plunged immediately into the fixative. If they are large, it is preferable to cut them into small pieces with a sharp scalpel under the fixative. The vacuum pump should be used in the same way as for root-tips.

For the Kihara method whole buds are taken, some of the outer bracts removed, but the anthers are not left exposed. They are then placed in Carnoy for from one to two minutes according to the size and nature of the bud ; the Carnoy is then poured off and replaced immediately by Bouin, Navashin, or one of the chrome-osmic fixatives. If possible, the sepals should be removed just before washing, since their removal aids infiltration and makes section cutting easier.

The smear method is most useful for obtaining perfect fixations of pollen mother-cells, especially in the prophase stages, and is also much less tedious than the paraffin method. The utensils required are a suitable dish (this should be 3½ inches square, and have two ridges running across the bottom, on which to support the ends of the slide), and a scalpel, to be used in making the



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smear. The scalpel may be replaced by a slide held sideways, in which case both slides can be placed in the fixative.

The method is best suited to plants with medium- or large-sized cells. Anthers of the stage required are placed on a clean slide about 1 inch from one end, and they are then crushed slightly with the scalpel or second slide, the anther contents being at the same time smeared evenly over the slide. The slide is then immediately inverted into a dish of fixative in such a way that all the cells come into contact with the fixative simultaneously. It requires some practice to learn how much pressure to use on the scalpel, and to acquire facility in making a rapid and even smear. Fixation is immediate; hardening is sufficient after 2 hours, after which period the slides are placed in running water for an hour. The slides will need bleaching if fixatives containing osmic acid have been used. This can be done by placing slides in a dish containing a solution of hydrogen peroxide (1 part 20 vol. peroxide to 2 parts distilled water) and exposing to a strong light for 20 minutes. After being rinsed in water the slides are ready for staining.

Washing, Dehydration and Infiltration.

There are several disadvantages in the usual method of washing material in running water. By using tepid water washing can be completed in a much shorter time with less risk of injuring the material. After fixation is completed, the fixing fluid is poured off and replaced by several changes of tap water. This is replaced by tap water, and the bottle placed on a thin piece of cardboard on top of the paraffin oven.* With half-hourly changes washing can be completed in 2 or 3 hours for root-tips and anthers, though flower buds require a longer time—about 4 hours.

Careful dehydration is necessary to obtain the best results. A series of alcohols from 10 p.c. to absolute is required. It is important that material should pass through the lower alcohols quickly up to at least 40 p.c. Material can be left safely in 70 p.c. alcohol, but for long periods it is better to use a mixture of glycerine and 70 p.c. alcohol (Calberla). It is desirable not to leave too long in absolute alcohol, but at least 12 hours are required, and in the case of large buds it is preferable to use two changes of absolute alcohol. Chloroform is better than xylol for clearing and infiltration. It does not harden material so much and evaporates more quickly.

Butyl alcohol has been recommended for woody tissues by Conway Zirkle. It can be used on buds and root-tips. Material can be taken up to paraffin wax in a much shorter time by this method. Callus of tomato stems prepared by Zirkle's method did not section so well as those taken up through n-butyl alcohol and then passed successively through 25 p.c., 50 p.c., and 75 p.c. chloroform in n-butyl alcohol. One hour in each is sufficient, and the material may then be taken into pure chloroform with wax.

* The type of oven used in this laboratory has two compartments, so the temperature is not very great on the oven top—about 30° C.

Schedule for Paraffin Method.

Divided into days, giving the most convenient stopping-places.

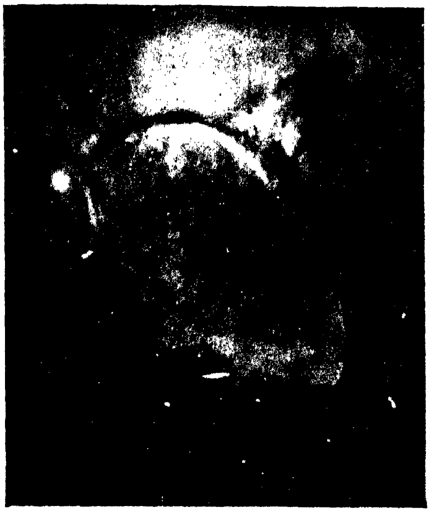
1st day	fix		leave overnight.
2nd day	wash		2–4 hours in tepid water.
	10 p.c. alcohol		½ hour.
	20 p.c.	,,	1 hour.
	30 p.c.	,,	3 hours
	40 p.c.	,,	overnight.
3rd day	50 p.c.	,,	3–4 hours.
	60 p.c.	,,	3–4 ,,
	70 p.c.	,,	12 hours at least (longer does no harm).
4th day	80 p.c.	,,	3–4 hours
	95 p.c.	,,	3–4 ,,
	absolute	,,	12 hours (not longer); two changes if material large.
5th day	1 part chloroform, 3 parts absolute alcohol, 2–3 hours.		
	2 parts ,, 2 ,, ,, ,, 2–3 ,,		
	3 ,, ,, 1 part ,, ,, 2–3 ,,		
	Pure chloroform plus a small piece of wax. The bottles should now be placed on the paraffin oven for 3–5 days, adding a small piece of wax every day, but never more than will go into solution.		
8th–10th day	The bottles should now be placed in the top compartment of the oven (40° C.) for 2 hours, and then in the bottom compartment (56° C.) for 4 hours, to evaporate the chloroform. Then embed.		

Embedding and Section Cutting.

After the material reaches the chloroform-wax stage, and has been on the oven top from 3 to 5 days, the bottles are placed in the top compartment of the paraffin oven for 2 to 3 hours, to obtain a necessary gradual change of temperature. The contents are then poured out into watch-glasses and placed in the bottom compartment to evaporate the chloroform. Four to 5 hours is sufficient for this process: the oven door is opened for a few seconds now and then during this period. In the meantime embedding dishes should be prepared: first they are smeared with xylol to remove any grease, and then with glycerine to prevent the wax from adhering. The dishes are placed in the oven so as to be at the same temperature as the melted paraffin wax used for embedding. A paraffin wax of 54° melting-point is suitable for summer and 50° for winter use. When the chloroform is evaporated, the material is poured into embedding dishes, together with melted paraffin, and orientated into the required position with warm needles. The wax must be rapidly cooled so that it does not become crystalline. Several devices have been suggested for this purpose. Good results can be obtained if one blows gently on the surface of the paraffin wax, so as to form a thin skin, before plunging the dish into cold water.

Cutting can be learned only by experience. A few important points to remember are:—

The block must be trimmed so that each section forms a perfect rectangle. Hard wax (54° m.p.) should be used for thin sections, and softer wax (50° m.p.)



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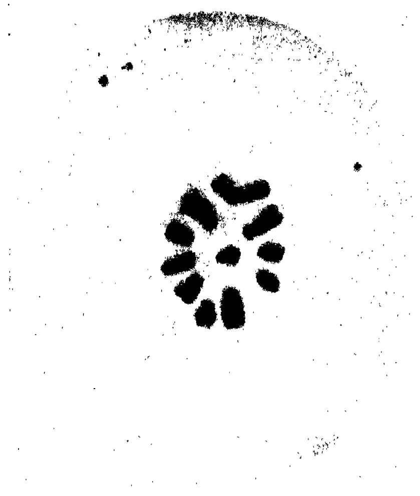

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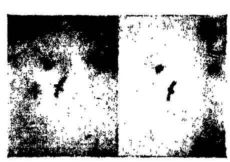
(a)



(b)

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for thick sections. Sections are fixed to the slide with Mayer's albumen fixative. A small drop is smeared evenly over the slide and then wiped off with a clean finger until only a scarcely perceptible film remains. The sections are floated on a few drops of water and the slide placed on a hot plate or bath for a few seconds to stretch the sections. The ribbons can be straightened during this period. Any water remaining should be carefully drained off and the slides left to dry for 3 or 4 hours. In the case of thick sections (over 16μ) a longer time is desirable. After drying, the paraffin wax is removed with xylol. It is better to have two jars containing xylol. The slides should be left at least 15 minutes in the first jar and rinsed in the second. The slides can then be taken down through absolute alcohol, 95 p.c. alcohol, and 80 p.c. alcohol, a few minutes in each being sufficient.

At this stage the slides are bleached, if necessary, by placing in a solution of hydrogen peroxide 20 vol. 1 part, 80 p.c. alcohol 3 parts, for 4–5 hours.

Staining.

The principal stains used are Heidenhain's iron-hæmatoxylin, and gentian violet, and more recently brazilin has been introduced by Belling. Hæmatoxylin has been very largely used, but gentian violet has several distinct advantages. Smears or sections are not in water for so long a period; it is quicker, and is more suitable for prophase stages owing to its transparency. It is possible to stain sections 40μ in thickness and obtain well-stained chromosomes with a clear cytoplasm. The only disadvantage is that the stain sometimes fades. This fading varies with the source and type of dye used. Staining is an art which requires practice to reach perfection. It is important that the student should know how thick to cut his material, as good staining depends largely on this.

With gentian violet the absolute alcohol removes the stain more quickly from the cytoplasm than from the chromosomes, while the clove oil acts in the reverse manner, removing the stain more rapidly from the chromosomes. Staining is better where differentiation is short.

Where gentian violet is to be used, the slides should be taken down through the range of alcohols and rinsed in water. The following method was devised by Newton (*cf.* Newton, D., 1929).

Stain (1 p.c. solution boiled and filtered) ..	3–10 minutes (according to age of stain).
Water	rinse.
1 p.c. iodine + 1 p.c pot. iodide in 80 p. alcohol ..	30–45 seconds.
Alcohol 95 p.c.	2 seconds.
Absolute alcohol	4 seconds.
Clove oil ..	differentiation under the microscope.
Xylol	3 changes (at least 15 minutes in xylol before mounting).

Mount in xylol-balsam.

In the case of certain genera, and often certain fixatives, it is sometimes difficult to obtain a satisfactory stain with gentian violet. In such cases the following modification of the ordinary staining schedule is to be recommended :—

1. Stain	10 minutes (3 hours when material has been fixed in Carnoy).
2. Rinse in water.	
3. Absolute alcohol	2 seconds.
4. Iodine-iodide-80 p.c. alcohol ..	2 minutes.
5. Absolute alcohol	2 seconds.
6. Chromic acid 1 p.c. aq. sol. ..	15 seconds.
7. Absolute alcohol	5 seconds.
8. Chromic acid 1 p.c. aq. sol. ..	15 seconds.
9. Absolute alcohol	10–15 seconds.
10. Clove oil.	
11. Xylol.	

Formulæ for Fixatives.

Medium Flemming.

30 c.c. chromic acid 1 p.c. aq. sol.
10 c.c. osmic acid 2 p.c. aq. sol.
25 c.c. acetic acid 5 p.c.

Benda (low acetic).

30 c.c. chromic acid 1 p.c. aq. sol.
10 c.c. osmic acid 2 p.c. aq. sol.
5 c.c. acetic acid 5 p.c.

Strong Flemming.

30 c.c. chromic acid 1 p.c. aq. sol.
10 c.c. osmic acid 2 p.c. aq. sol.
7 c.c. acetic acid 30 p.c.

Navashin's Fluid (after Karpechenko).

Chromic acid 10 p.c. aq. sol.	1·5 c.c.
Acetic acid 10 p.c. aq. sol.	10 c.c.
Formalin (40 vols.) 10 p.c.	8·30 c.c.
Distilled water	16·20 c.c.

Allen's Fluid (B–15).

Picric acid sat. aq. sol.	75 c.c.
Formalin	25 c.c.
Acetic acid, glacial	5 c.c.
Urea	2 gms.
Chromic acid	1·5 gms.

Carnoy's Fluid

Absolute alcohol	6 parts.
Chloroform	3 ,,
Acetic acid, glacial	1 part.

New Fixatives.

2B

Chromic acid 1 p.c.	90 c.c.
Potass. bichromate	1 gm.
Sod. sulphate	0·5 gm.
Urea	1 gm.
Acetic acid 5 p.c.	10 c.c.
Osmic acid 2 p.c.	15 c.c.
Distilled water	45 c.c.

2BE (best for root-tips, smears).

Chromic acid 1 p.c.	90 c.c.
Potass. bichromate	1 gm.
Saponine	0·05 gm.
Acetic acid 5 p.c.	10 c.c.
Osmic acid 2 p.c.	15 c.c.
Distilled water	45 c.c.

2BD (good for root-tips, and after Carnoy).

Chromic acid 1 p.c.	100 cc.
Potass. bichromate 1 p.c.	100 c.c.
Saponine	0·1 gm.
Osmic acid 2 p.c.	30 c.c.
Acetic acid 5 p.c.	30 c.c.

A higher percentage of acetic and osmic acid is required in these fixatives for the fixation of anthers.

The above new fixatives have been successful with the following genera, giving in every case better results than Flemming :—

2 B.—Root-tips of *Campanula, Datura, Melandrium, Papaver, Pentstemon, Portulaca* and ovaries of *Matthiola*. Smears of *Leucojum* (pollen grains) *Iris, Portulaca*. After Carnoy on flower buds of *Pisum*.

2 BE.—Root-tips of *Aconitum, Anchusa, Aquilegia, Brodiœa, Convallaria, Crocus, Dahlia, Digitalis, Fragaria, Fritillaria, Hieracium, Maianthemum,* Oats and Wheat (2n), *Œnothera, Polygonatum, Primula* and *Spartina*. Smears of *Fritillaria, Hemerocallis, Iris*. After Carnoy on flower buds of *Dahlia, Helianthus, Viburnum*.

2 BD.—*Root-tips of Sorghum,* other Grasses and *Viburnum.* After Carnoy on flower buds of *Aconitum, Pentstemon,* and *Sorghum* and other grasses.

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EXPLANATION OF PLATES.

Fig. 1.—Root-tip of *Digitalis purpurea* × *ambigua* (2n=112) (*cf.* Buxton and Darlington, 1931).

Fig. 2.—Root-tip of *Pennisetum clandestinum* (2n=36) fixed in 2BD.

Fig. 3.—Prophase stages in the vegetative mitosis of the pollen grain of *Leucojum æstivum*, smear fixed in 2B.

Fig. 4.—Anaphase of first pollen mother-cell division of *Œnothera* species, anthers dissected out and fixed in medium Flemming. Chromosome pair with interstitial chiasma lagging on the plate (Darlington, 1931).

Fig. 5.—Metaphase of first pollen mother-cell division of *Fritillaria imperialis*, 12 bivalents and 6 fragments (unpaired); smear fixed in medium Flemming (*cf.* Darlington, 1931).

Fig. 6.—Metaphase of first pollen mother-cell division of *Sorghum* species, whole bud fixed in Carnoy followed by 2BD.

Fig. 7.—Metaphase of the first vegetative division in the pollen grain of *Leucojum æstivum*, smear fixed in 2B.

Fig. 8.—Metaphase of first pollen mother-cell division of a dodecaploid species, *Pentstemon lævigatus* (2n=96), showing "secondary pairing;" whole buds fixed in Carnoy followed by 2BD.

Fig. 9.—Metaphase of first pollen mother-cell division of *Atriplex hortensis* (n=9); anthers dissected out and fixed in medium Flemming.

Fig. 10.—*Rosa* "Orleans"—(*a*) first metaphase in the pollen mother-cells: 6 bivalents and 2 univalents (2n=14); (*b*) two diakinesis bivalents with terminal and interstitial chiasmata (Erlanson, 1931); anthers dissected out and fixed in medium Flemming.

Figs. 1, 2, 3, 6, 8 and 9, microphotographs taken with single exposures. Figs. 4, 5, 10, microphotographs of a single cell at different foci taken with a cine-camera designed by H. C. Osterstock of this Institution. Fig. 9 stained by Heidenhain's iron-hæmatoxylin method, other figures by Newton's gentian-violet method.

IX.—EXPERIMENTAL STUDIES IN DIFFRACTION. II. 535. 42.

By Fredk. W. Shurlock.

Two Plates and Four Text-Figures.

The Formation of Images.

The object of this paper is to elucidate the part played by interference in the process of image formation, especially in the case of high-power microscope objectives, by means of experiments on a sufficiently large scale for their chief features to be readily observed.

According to the wave-theory of light, each point in the surface of a luminous body is a source from which small transverse waves are emitted. The wave-front from a point source in an isotropic medium is part of a spherical surface, and the vibrations at points in this surface are all in the same phase. The principle of Huyghens explains how the wave travels: it regards each point in a wave surface as the centre of a secondary wavelet, and any subsequent wave-front is the envelope of the secondary wavelets proceeding from the former. The familiar observation that light travels in straight lines or rays is explained by the principle of Huyghens, combined with the principle of interference, and the demonstration shows that the ray is an ideal conception, which is never actually realized in practice, and that its approximate realization is due to the small size of the light waves. The light ray is, nevertheless, within proper limits a very useful conception, and enables us to discuss the formation of optical images by the methods of geometrical optics.

The image-forming properties of rays of light may be illustrated by the following well-known experiment. Using a strong source of light, e.g., a direct current arc in an optical lantern, let us remove the condenser and place in the slide-carrier a metal plate with a large hole which has been covered with tinfoil. If we now prick a small hole in the tinfoil with a fine needle, an image of the arc immediately appears on a white screen placed at a convenient distance from the lantern. The formation of the image may be regarded in this way. A cone of light rays of wide angle is emitted in front of the arc from every point in the arc. From each point a cone of very small angle passes through the pinhole and illuminates a small area of the screen, the intensity and colour of the illumination depending on the character of the light emitted by the corresponding point in the arc. In spite of some slight overlapping of the small illuminated areas from adjacent points in the

arc, they combine to produce an image of the arc on the screen which is geometrically similar to the arc itself, and in which the distribution of intensity and colour resembles that in the arc. This image is, of course, inverted, since the small cones of light from different points in the arc cross at the pinhole. We may regard the pinhole as a geometrical point, through which a single ray from each point in the arc passes to form the image of the corresponding point in the arc on the screen. In doing this we must clearly consider the ray to possess the power of forming the image of the point in the arc from which it originates at the point where it strikes the screen.

If we now prick a number of small holes in the tinfoil, a corresponding number of images of the arc appear on the screen. As the number increases, these will overlap, and if finally we remove the tinfoil, we shall have on the screen a uniformly illuminated area due to the overlapping of the pinhole images of the arc from each point in the large aperture.

If, instead of removing the tinfoil, we place a convex lens in front of it, the images of the arc will approach one another, owing to the refraction of the rays by the lens, and a position for the lens can readily be found which will cause the images to coalesce, forming a single and, of course, much brighter image of the arc. The image has now been focused by the lens.

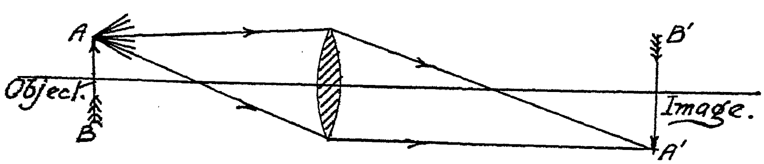


Fig I

Fig. 1 shows the cone of rays from the point A which falls on the lens and forms the image of the point A at the point A′ on the screen. From each point A in the object a cone of rays passes through the aperture; the rays are refracted by the lens and meet at the point A′ on the screen, forming the focused image of A.

In the case of self-luminous objects like the arc, and of objects illuminated by diffused light, we may suppose each point of the surface to be a source of rays diverging from the point in every direction that is geometrically possible. It remains to consider the case in which objects are illuminated by rays from a separate source of light.

Let us take as our object a wire ring with two cross-wires, diameters of the ring, at right angles to each other, and let us illuminate this opaque object by a point-source of light on the axis of the ring. We can conveniently effect this by focusing the image of the arc on a metal plate in which a small pinhole has been drilled. Since the image of the arc is focused on the plate, rays from a small portion of the surface of the arc cross at the pinhole and give rise to a small cone of light, the axis of which is normal to the plane of the ring.

Rays which meet the opaque wire are quenched or reflected backwards towards the source. Rays which do not meet the wire pass on unchanged. If we now place a white screen on the side of the object remote from the source of light, we have depicted on the screen a sharp shadow of the opaque object. This shadow is geometrically similar to the object, and may be regarded as an image of the object. It, of course, increases in size as the distance of the screen from the pinhole source increases. This shadow image can be obtained at any distance within the working limits.

If a convex lens be inserted in the beam at a distance from the object greater than its focal length, the divergent cone of rays from the pinhole source is converted into a convergent cone by the lens, and the decreasing shadow of the object may still be traced to within a short distance of the point where the pinhole is focused ; after passing this point the shadow again appears, but is now inverted. As the distance from the vertex of the cone increases, the inverted shadow increases in size, but is otherwise indistinguishable from the image in the plane conjugate to that of the object.

These features are illustrated in figs. 2, 3, 4 and 5. Fig. 2 is the shadow of the object at a distance of 2 cms. from the object, the form of which it clearly represents. The focal length of the lens employed was 22·5 cms. Fig. 3 is the shadow at a distance of 29 cms. from the object where the light is about to enter the lens. Fig. 4 is the shadow in a plane between the lens and the focus of the pinhole at a distance of 15 cms. from the lens, where the shadow is decreasing in size. Fig. 5 is the inverted image of the object in the plane conjugate to that of the object. It differs only in size from the shadows in neighbouring planes.

Using a double pinhole, we obtain two shadows of the object as in fig. 6, which, when focused by the lens, gives fig. 7 (similar to fig. 5) in the plane conjugate to that of the object.

With three pinholes three shadows are obtained as in fig. 8, which, when focused by the lens, yield the single reduced image fig. 9.

If the pinhole is replaced by a larger source, we may suppose that each point in the source prints a shadow of the opaque object on the screen; but these shadows do not coincide, with the result that the actual shadow on the screen becomes more and more blurred as the source increases in size, until it can no longer be distinguished as an image of the object. The above experiments suggest that when a lens system is used to form a real image of an opaque object, we may regard the image as the focused shadow of the object.

Let us now examine the illumination of a point in the plane of the object where the light is not obstructed by the object, when the source of light is of considerable size. It will be convenient to consider a point just outside the ring.

In fig. 10, AB is a diameter of the source and CD a parallel diameter of the ring. ACE is the tangential ray from the point A in the source at the point C in the edge of the wire, and similarly BCF is the tangential ray

from the point B in the source at the same point C. The tangential ray at C from any intermediate point in AB will clearly lie within the angle ECF, and there will diverge from the point C on the side remote from the source

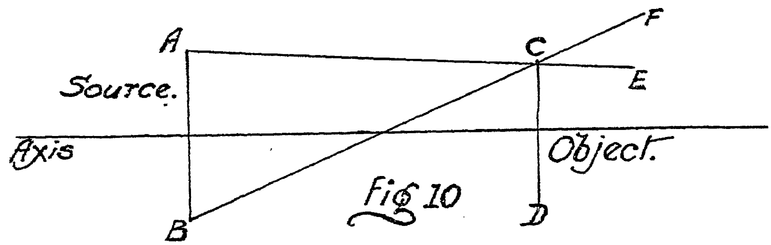


Fig 10

a cone of tangential rays of which the section in a plane parallel to those of the source and object will depend on the shape of the source. A cone of rays will obviously be formed in this way, not merely at the edges of the wire but from every point in the plane of the object which is illuminated by the source and where the light is not obstructed by the wire.

If we now insert a convex lens in a suitable position on the side of the object remote from the source, the diverging cone from the point C just outside the wire will be converted by the lens into a converging cone and will be brought to a focus at the point C′ on the other side of the axis from C.

In a microscope used with critical illumination, if we suppose the object

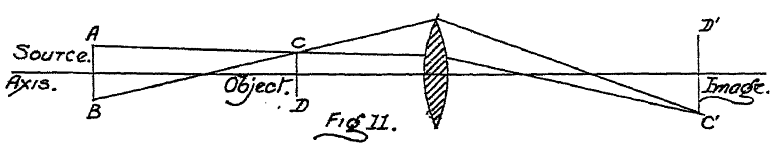
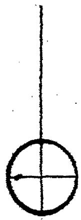


Fig 11.

to be of negligible thickness, we may regard the source of light as coincident with the object, so that a cone of rays will diverge from each point in the object at which light is transmitted, the angle of the cone being determined by the condenser. Parts of the object may be opaque, whilst other parts may exhibit various degrees of transparency. At points where the transparency is imperfect there will be a certain amount of scattering of the light, and these scattered rays will also contribute to the cone of rays from each point which enters the objective and is focused as a real image in the conjugate plane.

Remembering that both the formation of rays and the formation of shadows are interference effects, it will be clear that the formation of an image by a lens-system is in every case due to interference.

The photographs in figs. 2–5 reveal, on examination, interesting interference effects which may serve to remind us that shadows are regions in which there has been destructive interference of the secondary wavelets rather than regions from which all light waves have been excluded. In



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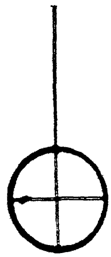

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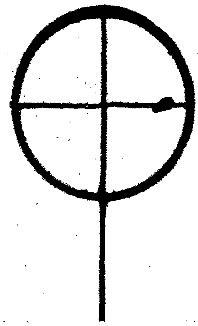

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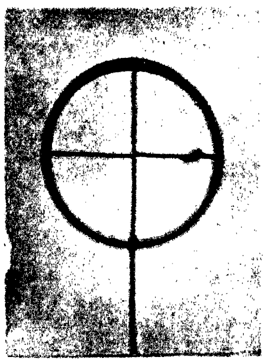

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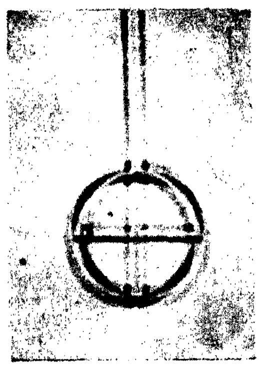

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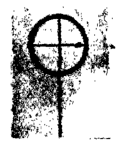

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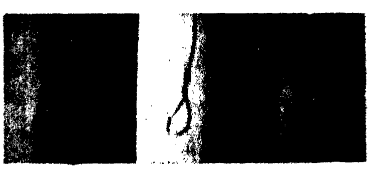

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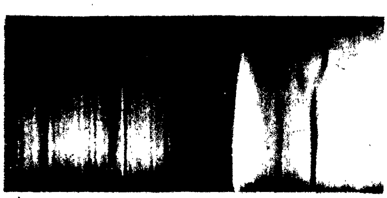

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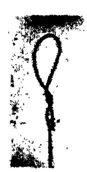

16

fig. 3, for example, the suspending wire and cross-wires have a bright centre; there are two dark circles due to interference in the ring, and parts of the ring consist of small radial dark patches alternating with others which are less dense. Similar features may be noticed in fig. 4. They are practically eliminated in the focused image. The ring was actually a short cylinder, and the varying thickness seen in the image is due to a slight want of symmetry in the axial adjustment.

Thus far we have considered only the formation of the dioptric image or image by refraction by the methods of geometrical optics. As long as there is no definite splitting of the incident cone of rays by diffraction, these methods suffice to furnish an adequate mental picture of the process of image formation; this is the case when the parts of the object to be delineated in the image are relatively large compared with the wave-length of the light employed. Where, however, in the formation of images by high-power microscope objectives, the parts of the object to be delineated are often comparable in size with the wave-length employed, and consist of minute repeated structures which give rise to a number of diffracted beams, each of which—if it enters the objective—contributes to the formation of the image, the ray method alone no longer suffices to furnish an adequate mental picture of the process of image formation.

It is therefore necessary to consider the contribution which small repeated structures in the object make to the image formed by the objective. Now, the simplest repeated structure is the ordinary optical grating, which consists of alternate opaque and transparent straight lines placed at regular intervals. The theory of optical gratings is fully treated in standard text-books, and experiments with such gratings serve to throw light on the process of image formation in a microscope.

We select, therefore, as our object an optical grating with a loop of thin wire suspended in contact with it. The loop furnishes an opaque object similar to that previously employed, whilst the lines of the grating supply the fine detail. As the source of light we employ a narrow slit illuminated by approximately monochromatic yellow-green light from an arc spectrum. The grating and wire loop are placed at a convenient distance (say 30 cms.) from the slit, with the lines of the grating parallel to the slit. A focusing lens of large diameter at a similar distance from the grating receives the diffracted beams from the grating, and a white cardboard screen may be used to explore the beams before and after passing through the lens. The apparatus is conveniently set up on an optical bench, and its general arrangement is shown in fig. 12.

Using a celluloid grating with 3001 lines to the Paris inch* (or 2815 lines per inch), seven or eight diffracted beams may be distinguished on each side of the central beam, between the grating and the lens. A focusing lens of 4 inches diameter and 22·5 cms. focal length, placed at a distance of 30 cms.

* The Paris inch = 2·707 cms.

from the grating, will transmit four or five of the beams. On passing through the lens the beams are refracted and form a convergent system, each beam assuming the form of a convergent wedge and giving rise to an image of the slit in the plane conjugate to that of the slit. These images of the slit are, in fact, monochromatic spectra, and with white light the ordinary coloured spectra would be obtained, only the central beam giving rise to a white image of the slit. After passing the plane of the spectra, each beam becomes a divergent wedge, but as the axial rays converge, the light from the several beams overlaps to form the image of the grating surface and wire loop in the conjugate plane of the grating. The shadow of the wire loop may be detected,

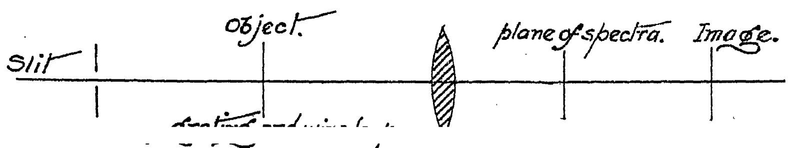

Fig. 12.

not only in the central beam, but also in the diffracted beams, and may be traced on both sides of the lens, as in the earlier experiment. Between the grating and the lens the shadows naturally increase in size as the distance of the screen from the grating increases. Between the lens and the plane of the spectra the shadows decrease in size as the distance of the screen from the lens increases, and are indistinguishable in the neighbourhood of the spectra. Between the spectra and the plane of the image the shadows may again be distinguished; they are now inverted, and as the screen approaches the image-plane they increase in size, approach nearer together, and finally coalesce to form the image of the loop. With white light the shadows, with the exception of that in the direct beam, disappear, since the shadows due to the different wave-lengths tend to obliterate one another.

It will be convenient to distinguish the diffracted beams by numbers denoting the orders of the spectra to which they severally give rise, the central direct beam being denoted by zero.

Fig. 13 is a photograph of the shadows in the beams 1, 0, 1 at a distance of 6·5 cms. from a celluloid grating with 14,000 lines per inch. This grating would, however, require a lens of inconveniently large aperture to transmit the diffracted beams.

Figs. 14, 15 and 16 are photographs taken with the celluloid grating of 3001 lines to the Paris inch and the lens of 4 inches diameter and 22·5 cms. focal length.

Fig. 14 shows the spectra in the plane conjugate to that of the slit arising from the beams 3, 2, 1, 0.

Fig. 15 shows the inverted shadows in the beams 4, 3, 2, 1, 0 between the plane of the spectra and the image-plane. The shadows in the beams 4 and 3 are clearly shown. The beam 1 overlaps the central beam and 2 is weak.

Fig. 16 shows the focused image. Besides the image of the wire loop the photograph shows a number of marks on the surface of the grating due to wear, but there is no trace of the image of the lines of the grating.

These experiments suggest that in the case where the object contains minute structure which gives rise to diffracted beams, we may still regard the dioptric image, i.e., the image due to refraction, as the focused shadow of the opaque parts of the object, and make it clear that, whilst the direct beam can furnish an adequate dioptric image, the diffracted beams also contribute to it.

We proceed to substitute a coarser grating, using for this purpose a contact copy of a piece of process screen ruled with 150 lines to the inch, the lines and spaces being of equal width. This, together with the wire loop, forms the object. A lens of 12 inches focal length is employed to form the spectra and the image. The spectra, which in the experiment of fig. 14 were about 9 mm. apart, are seen to be much closer together, the separation now being 0·83 mm., as shown in fig. 17. It will be observed that the focused images shown in figs. 18 and 19 now reveal the lines of the grating.

In the experiment which corresponds to fig. 18 the distance of the lens from the grating was 33 cms., and the distance of the image from the lens was 127 cms. The image has 40 lines to the inch, and agrees closely with the magnification calculated from the distance.

In the experiment which corresponds to fig. 19 the distance of the lens from the grating was 40 cms., whilst the distance of the image from the lens was 90 cms. The image has 65 lines to the inch, and this is again in close agreement with the magnification, as calculated from the distances.

It remains to consider the way in which the image of the lines of the grating is formed. In the experiments which follow, parallel light was employed, a collimating lens being introduced between the slit and the grating. For convenience in selecting the spectra, the light from which was allowed to pass to form the interference figure, an adjustable spectrum-gate was placed in the plane of the spectra. The jaws of the spectrum-gate limited the number of spectra from which light could pass, and others could be stopped out by means of wires or strips. The wire loop was omitted, so that the grating alone formed the object.

To obtain figs. 20, 21 and 22 the grating employed was a piece of process screen ruled with 133 lines to the inch, an arc focused on the slit being used as the source of light. The spectrum-gate was placed 29 cms. from the focusing lens. It was found that the interference pattern could be obtained at any distance between 40 cms. measured from the spectrum-gate up to nearly 4 metres, the limit of the working distance. These photographs show the interference patterns at distances of 40, 46 and 145·5 cms. respectively from the spectrum-gate. The conjugate image-plane coincided with the plane of fig. 21, so that fig. 20 is an interference pattern within the conjugate focal distance, fig. 21 the pattern at the conjugate focal distance, and fig. 22

a pattern beyond the conjugate focal distance. The intervals by which the lines are separated are respectively 0·24 mm., 0·28 mm., and 0·88 mm.

The patterns differ only in the magnification, and, as before, the measured magnification is in agreement with the magnification as calculated from the distances of the object and image from the focusing lens.

The measurements form a consistent set on the supposition that the lines are interference lines, due to sources in the position of the spectra similar to those of the fundamental interference experiment in which a double slit is illuminated by light from a single parallel slit.

The light at corresponding points in any two spectra is constantly in the same phase, and hence, at any distance where the light cones from the two spectra overlap, interference bands are obtained exactly as in the case of Fresnel's mirrors or the biprism. The only difference is that whereas in the case of Fresnel's mirrors the two sources are formed by reflection, whilst in the case of the biprism they are formed by refraction, in this experiment they are formed by diffraction.

If the spectra act as separate sources, the light in which, at corresponding points, is constantly in the same phase, no single source should be able to give rise to the interference pattern, and this is readily verified by stopping out all but one of the monochromatic spectra at the spectrum-gate. It also follows that the light from any two spectra should give rise to interference lines except in so far as the effect is masked by differences in intensity. This also can be easily verified, and is, in fact, exemplified in the experiments now to be described in illustration of Abbe's well-known grating experiment.

In this experiment a grating having alternate long and short lines is placed on the stage of the microscope so that one-half of the field is occupied by a grating having twice the number of lines of the grating in the other half of the field. The gratings give rise to two rows of spectra in the back focal plane of the objective, one of which, viz., that corresponding to the grating with the smaller number of lines, has twice the number of the spectra in the second row. On stopping out every alternate spectrum in the more numerous row and viewing the image with the eyepiece, the short lines appear continuous throughout the field, and are indistinguishable, in fact, from the long lines; in other words, the lines in one-half of the field have been doubled.

Using parallel yellow-green light and the grating with 150 lines to the inch, a similar experiment may be performed with the arrangements described above. To obtain figs. 20, 21 and 22, the 12-inch focusing lens was employed, and the photographic plate was situated 165 cms. from the spectrum-gate. To obtain fig. 23, all the beams were allowed to pass; for fig. 24, only the three beams 1, 0, 1 were admitted; and for fig. 25, only the two beams 1, 0 were admitted to form the interference pattern.

The separation of the lines is in each case 1 mm., indicating that the spacing of the lines depends on the spacing of the spectra and not on their


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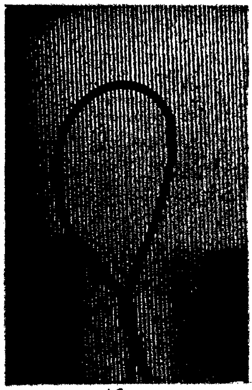
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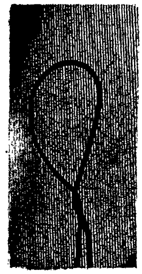
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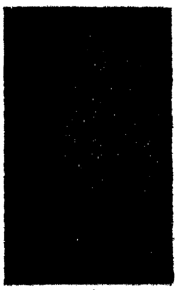
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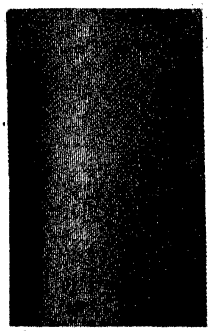
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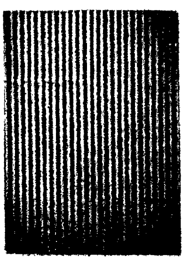
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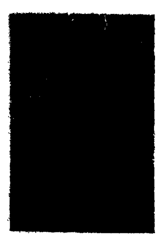
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number. The lines in fig. 23 are sharper than those in figs. 24 and 25, so that the inclusion of additional spectra appears to sharpen the lines.

Stopping out the central beam and leaving only the spectra 1, 1, the separation of which is twice that previously employed, we obtain fig. 26, in which the separation of the lines is 0·5 mm., so that the lines are doubled. When only the second order spectra 2, 2 are included, we obtain fig. 27, in which the separation of the lines is 0·25 mm., the lines being again doubled. If finally we exclude the spectra 1, 0, 1, allowing the second and higher order beams to pass, we obtain in fig. 28 the 0·25 mm. lines corresponding to the spectra 2, 2, the 1 mm. lines corresponding to the spacing of the higher order spectra being strongly accentuated.

It appears, then, that we may regard the image formed by a microscope objective of an object comprising minute structure which gives rise to diffracted pencils of light as consisting of a dioptric image with an interference pattern superposed.

The dioptric image arising from focused rays and focused shadows is necessarily the result of the interference of waves. It is, however, adequately conceived as formed by the refraction of rays of light emitted by the object which it resembles in form. All the diffracted pencils which pass through the objective contribute to the dioptric image in exactly the same way. The central pencil is to be reckoned among the diffracted pencils, and itself suffices for the formation of the dioptric image. Further, this dioptric image, in the case of a well-designed lens system, lies in a single plane.

The interference pattern, on the other hand, must be regarded as directly due to the reinforcement in some places and the extinction in others of the waves of light in those regions where two or more of the diffracted pencils overlap. The interference pattern, which requires at least two overlapping pencils for its formation, can be obtained at any distance beyond a certain minimum from the back focus of the objective, and, unlike the dioptric image, is not confined to a single plane.

In the case of the simple grating consisting of alternate transparent and opaque lines, the interference pattern resembles the minute structure in form. In other cases conclusions as to the form of the fine structure should be drawn with reserve, and a knowledge of the diffraction patterns in standard cases should prove helpful.

578. 67.

X.—A PARAFFIN EMBEDDING APPARATUS.

By Geo. C. McLennan, Veterinary Pathologist, Government Laboratory of Pathology and Bacteriology, Adelaide, South Australia.

(*Read February* 18, 1931.)

Two Text-Figures.

McClung (1929), in his work on "Microscopical Technique," suggests a method of embedding tissues, etc., by which the material to be treated is kept at the exact melting-point of the particular wax being used.

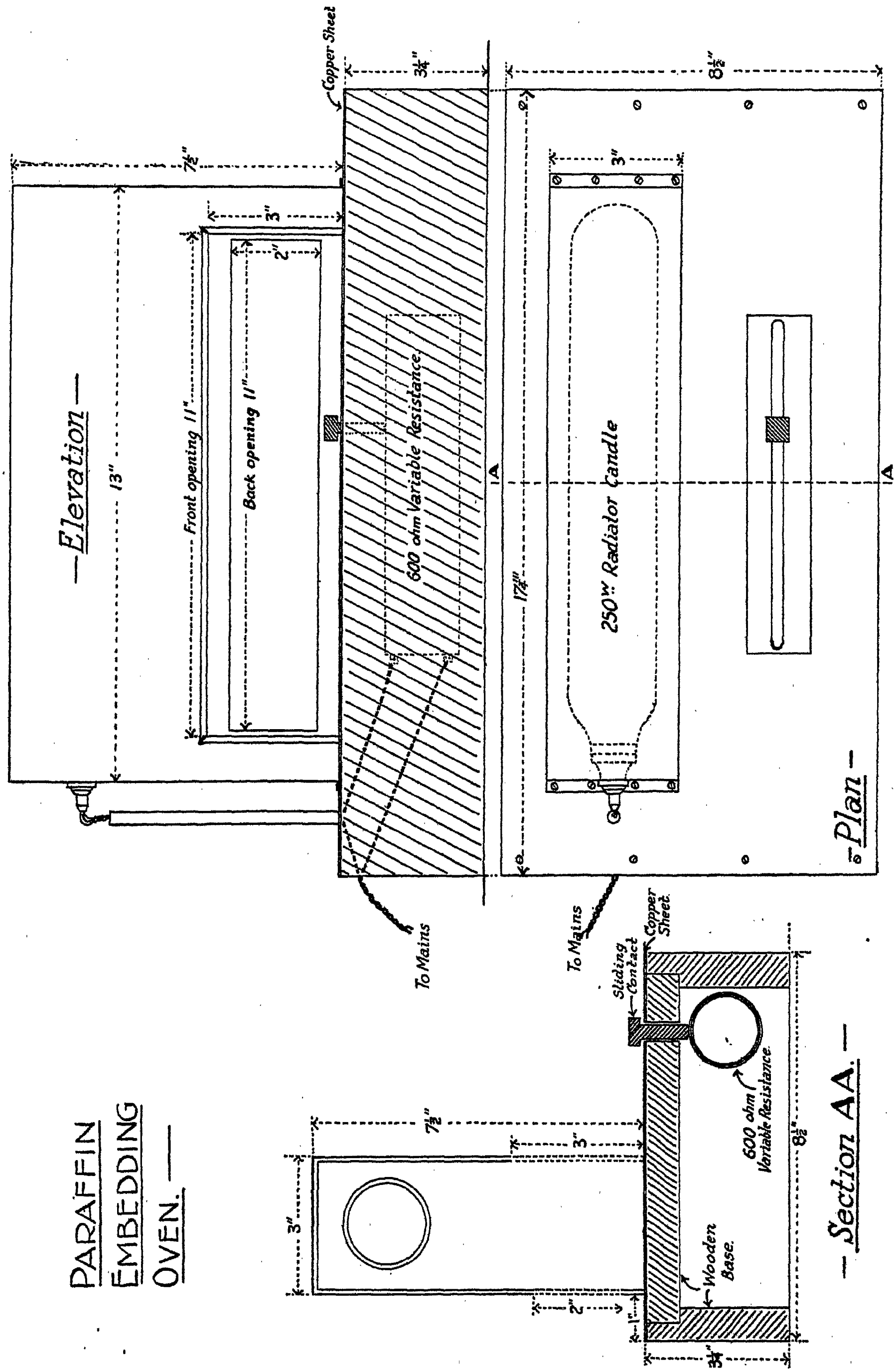
Craig-Bennett (1930), has recently published a description of an embedding oven based on McClung's suggestion.

The apparatus here described is also based on McClung's idea. It was found in this laboratory, where the room temperature is often in the vicinity

of 35° C. during the summer, that the whole of the wax in the container, when subjected to the uncontrolled heat from the 150-watt lamp, soon became heated considerably above its melting-point. Even in winter it was found necessary to keep the apparatus under continual observation, in order that the depth of melted wax in the containers might be controlled.

The oven described here has enabled this difficulty to be overcome, as the heat from the lamp is controlled by a variable electrical resistance.

In this apparatus the level of the melted, in relation to the solid, wax has been kept constant for six days, the longest period over which the oven



PARAFFIN EMBEDDING OVEN.
Elevation
Plan
Section AA.
Copper Sheet
600 ohm Variable Resistance.
250 W. Radiator Candle
Front opening 11"
Back opening 11"
To Mains
Sliding Contact
Wooden Base.
13"
7½"
3"
2"
3¼"
8½"
17¼"
1"
A

has, so far, been run. There appears to be no reason why it should not function successfully over much longer periods.

If there should be a tendency for the level of the melted wax to fall, due to increased room temperature, more resistance is put into the circuit, thus decreasing the temperature of the lamp, and *vice versa* should the level rise.

The accompanying photograph and drawing should enable anyone to construct the oven should they desire to do so. The material used, with the exception of the wooden base, was 26-gauge sheet copper.

It is not intended to patent the idea.

REFERENCES.

Craig-Bennett, A. (1930).—" An Embedding Apparatus for Research Workers." J. Roy. Micr. Soc., 50, New York, 218.

McClung, C. E. (1929).—" Handbook of Microscopical Technique." pp. 13–14.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(*Under the direction of* G. M. Findlay, M.D.)

HISTOLOGICAL TECHNIQUE AND STAINING.

A New Rapid Staining Method.—C. F. Geschickter, E. P. Walker, A. M. Hjort and C. H. Moulton ("A New Rapid Method for Tissue Diagnosis," *Stain Technol.*, 1931, **6**, 3–12, 1 text-fig.). A rapid new method of staining, applicable to both fresh and formalin frozen sections, is here described. The essential features are as follows:—(1) A buffer solution or prestaining bath, of the following composition, is used to collect the sections as they come from the microtome: potassium acid phosphate 6·75 gm., normal sodium hydroxide 30·00 c.cm., distilled water 570·00 c.cm., glycerine 200·00 c.cm., alcohol 95 p.c. 200·00 c.cm. The ingredients should be mixed in the order given. (2) The sections are then passed into the following staining solution for from 20 to 30 seconds: thionin eosinate 0·75 gm., barium eosinate 0·25 gm., azure A 0·25 gm., dissolved in 100 c.cm. of a mixture of 4 parts ethylene glycol and 1 part ethyl alcohol (95 p.c., plus 0·2 p.c. glacial acetic acid). Other stain combinations, using the same solvents, are under investigation. (3) The excess of stain is then washed off in two successive changes of 95 p.c. alcohol containing 20 c.cm. of glycerine to each 80 c.cm. of alcohol. The tissue is left in the first bath about 10 seconds and washed back and forth, and is then transferred to the second bath for about 3 seconds. If the sections are too blue, they are washed longer in the second bath, or two to three drops of 5 p.c. glacial acetic acid are added to the first bath. (4) The section is next dehydrated by floating for 10 to 15 seconds in a solution of diethylene glycol monobutyl ether. (5) The section is now cleared in *n*-butyl phthalate by floating in this solution for 20 seconds, dried on a glass slide by blotting with photographic lintless blotting-paper, and mounted in gum damar.

G. M. F.

A Specific Stain for the Basophilic Granules of Mast Cells.—E. Bujard ("Une coloration strictement élective des granulations basophiles des mastocytes," *Bull. d'histol. appl.*, 1930, **7**, 264–9). Tissues are fixed in either alcohol, formol-saline, alcohol-formol or bichromate-formol. After removal of the paraffin the sections are stained in 1 p.c. aqueous acid fuchsin for 30 seconds, rinsed rapidly in water, and treated with an aqueous solution of 0·8 p.c. bromine, for 4 to 5 minutes, until violet, in a closed container. Wash in water, differentiate in 95 p.c. alcohol or acid alcohol (1 p.c. H.Cl.) 1 to 3 minutes until light mauve. The fuchsin precipitate should be dissolved out of all the preparations except the granules. Differentiation

and dehydration are carried out with absolute alcohol, taking care not to destain the mastocytes. The sections are cleared in xyol and mounted in balsam. The granules are carmine red, while the nuclei and cytoplasm are colourless. Nuclei may be stained after the granules if desired. In this case rinse in water after differentiation of the granules. Mordant in 4 p.c. iron-alum for 4 minutes at 50° C. or for 40 to 50 minutes at room temperature. Stain with Regaud's hæmatoxylin for the same time at room temperature. Differentiate in 1 p.c. iron-alum and proceed as usual, timing carefully the alcohols. Nuclei are black, granules red. No acid stain could replace the acid fuchsin, but the reaction was positive with the following basic stains—fuchsin, methyl green, and violet. Basic fuchsin and Merck's "diamant fuchsin" proved as good as acid fuchsin, but granules are of a rather purplish red. Thionin, toluidin, and methylene blue are also good, the reaction being dark blue, slightly metachromatic. In order to throw some light on the reaction, bromine was replaced by various acids or oxidizing agents, using the same three stains, acid and basic fuchsin and toluidin blue. Toluidin blue alone gave positive results with acids; basic fuchsin and toluidin blue with oxidants and Lugol's solution. The reaction may be due to an energetic absorption of the precipitate by the basophilic granules or to an elective affinity of the granules to the new stains formed during the reaction. G. M. F.

The Staining of Spirochætes.—M. B. K. Harris ("A Simple Method for Staining Spirochætes," *Sc.*, 1930, **72**, 275). This is a modification of the method of Kliewe (Centralbl. f. Bakt. I. Abt. Refr., 1924, **76**, 232). A film is prepared and air-dried, being subsequently passed several times through a Bunsen flame. It is mordanted in a 1 p.c. aqueous solution of potassium permanganate for from 8 to 10 minutes, washed in water, stained for from 8 to 10 minutes with a 2 p.c. aqueous solution of methyl violet and again washed in water. In staining *Treponema pallidum* it is best to warm the mordant gently on the slide, but it is never necessary to warm the stain. For coarse spirochætes the staining period is shorter than for the delicate ones. With this method the spirochætes stain bluish-black and stand out very clearly. G. M. F.

The Staining of Bacterial Flagella and Capsules.—E. Leifson ("A Method of Staining Bacterial Flagella and Capsules, together with a Study of the Origin of Flagella," *J. Bact.*, 1930, **20**, 203–11). Growth from the base of an agar slant or from a bouillon culture recentrifuged and resuspended in distilled water, is smeared over a scrupulously clean slide. The following staining solution is used: ammonium or potassium alum. sat. aq. sol. 20 c.cm, tannic acid (20 p.c. aq. sol.) 10 c.cm., distilled water 10 c.cm., ethyl alcohol 95 p.c. 15 c.cm., basic fuchsin, saturated alcoholic sol. 3 c.cm. The ingredients are mixed in the order given, and the solution remains good for a week or more. Stain for 10 minutes in a warm room or in the incubator. A good counterstain, when fuchsin has been employed, is 0·1 p.c. aqueous methylene blue with 1 p.c. borax, or, if the flagella are blue, carbol fuchsin diluted 1 in 10. G. M. F.

Carmine Iron Acetate in the Study of the Chromosomes of Animals.—F. A. Saez ("Le carmin acétique ferrique dans l'étude des chromosomes des animaux," *Arch. de la Soc. de Biologia de Montevideo*, 1929, **1**, 258–61). The method is a modification of that used by Belling (Biol. Bull., 1926, **50**). The reagent is prepared as follows:—1 gm. of iron (needles or nails) is placed in 40 c.cm. of glacial acetic acid together with 10 c.cm. of hydrogen peroxide. The mixture is warmed for some minutes until an orange colour appears, then cooled and filtered. The carmine acetate is prepared by saturating with carmine a 45 p.c.

solution of acetic acid, heating on the water bath and filtering. The carmine acetate is added to the ferric acetate until the colour is red with a tinge of blue. An excess of ferric acetate may produce a precipitate of the colouring matter.

G. M. F.

Cytology.

The Harderian Gland and Xerophthalmia.—E. TREACHER COLLINS ("The Harderian Gland: Xerophthalmia: Vitamin A Deficiency: Keratomalacia," *Trans. Ophthalmol. Soc.*, 1930, **50**, 201–30, 1 pl.). In primates the disappearance of the Harderian gland is compensated for by an increased development of unicellular mucous glands (or goblet cells) in the retrotarsal folds and ocular conjunctiva. In human beings whose diet is deficient in vitamin A the mucus-secreting cells of the conjunctiva atrophy and cease to function, so that keratinization of its epithelium takes place. G. M. F.

The Golgi Apparatus of the External Secreting Cells of the Pancreas in Certain Pathological and Physiological Conditions. — W. BUFIO ("L'appareil de Golgi de la cellule exocrine du pancreas dans quelques états physiologiques et pathologiques," *Compt. rend Soc. de Biol.*, 1931, **106**, 839–41). As compared with the fasting rabbit, the pancreatic cells during digestion have a Golgi apparatus which has more threads, while the trabeculæ are finer and more tortuous. In animals which have died of starvation the Golgi apparatus is fragmented. G. M. F.

Non-Disjunction of Chromosomes.—M. DEMEREC and J. G. FARROW ("Non-Disjunction of the X-chromosome in *Drosophila virilis*," *Proc. Nat. Acad. Sc.*, 1930, **16**, 707–10). It was found that the frequency of primary non-disjunctions was one in about 1,500 individuals: the female to male ratio for primary non-disjunctions was 1 : 19 : primary males were sterile: the frequency of secondary non-disjunctions was one in 1,120 individuals, and the female to male ratio for secondary non-disjunctions was approximately one to one. G. M. F.

X-Rays and the Frequency of Non-Disjunction of Chromosomes.—M. DEMEREC and J. G. FARROW ("Relation between the X-Ray Dosage and the Frequency of Primary Non-Disjunctions of X-Chromosomes in *Drosophila virilis*," *Proc. Nat. Acad. Sc.*, 1930, **16**, 711–14). At low dosages the increase in the percentage of primary non-disjunctions was found to be almost proportional to the X-ray dosage applied. Between 1,200 and 2,000 *r*-units the curve shows a sharp break, the increase in the percentage of non-disjunctions becoming smaller. Since at about the same point the fertility of treated flies begins to decline, it is suggested that at higher dosages the offspring which would have shown non-disjunctions is killed off by X-rays in a larger proportion than the regular offspring.

G. M. F.

Herpetic Encephalitis of the Porcupine.—P. REMLINGER and J. BAILLY ("L'encéphalite herpétique du porc-épic (*Hystrix cristata*)," *Compt. rend. Soc. de Biol.*, 1931, **106**, 81–2). Intracerebral inoculation of material containing herpetic virus produces an encephalitis, the incubation period being from two to three days.

G. M. F.

The Action of Embryo Extract on the Rate of Regeneration of Tissue Cultures.—B. EPHRUSSI ("Action de l'extrait embryonnaire sur la vitesse de régénération des cultures de tissus," *Compt. rend. Soc. de Biol.*, 1931, **106**, 546–8). When a culture of fibroblasts is wounded by excision of a small number of cells

the fibroblasts surrounding the wound grow more rapidly than those of the rest of the culture. This regenerating tissue also reacts more readily than the uninjured cells to the administration of embryo extract. G. M. F.

Chromosomes in Saurians.—R. Matthey ("Chromosomes de reptiles sauriens, ophidiens, chéloniens. L'évolution de la formule chromosomiale chez les sauriens," *Rev. suisse de Zool.*, 1931, **38**, 117–86, 8 pls., 19 text-figs.). Thirty species of reptiles belonging to the Saurian, Ophidian and Chelonian orders have been examined. All these species have a single male gamete, corresponding to a heterochromosomic formula XX. This formula is general in reptiles. The identification of heterochromosomes is only rarely possible. The evolution of the chromosome formula of the saurians can be explained on very simple hypotheses, such as have been proposed by Robertson (J. Morph., 1916, **27**). The principal family types of the same order must have appeared suddenly, since there are no intermediate forms and almost at the same time, originating from a single type endowed with extraordinary rich potentialities. G. M. F.

The Genesis of the Corpuscles of Hassall in Human Pathological Thymuses.—P. Bastenie ("La genèse des corps de Hassall dans les thymus humains pathologiques," *Compt. rend. Soc. de Biol.*, 1931, **106**, 55–6). The observations here recorded show that the corpuscles of Hassall arise from the adventitia and the perithelial cells of the capillaries. Reconstitution of such Hassall's corpuscles shows tubular formations twisting and bifurcating like the capillaries from which they arise. During involution there is a diffuse formation of Hassall's corpuscles arising, not from the capillaries but from the infiltrated reticulum of the connective tissue. G. M. F.

Kurloff Bodies.—E. Semenskaja ("Contribution à l'étude des corps de Kurloff," *Compt. rend. Soc. de Biol.*, 1930, **105**, 771–3). Kurloff bodies are said to be products of secretion of the lymphocytes in the blood of the guinea-pig. There is an intimate relation between the number of Kurloff bodies and the activity of the cells: pregnancy, for instance, greatly increases the number. The number also increases after castration and starvation, but decreases during infection.
G. M. F.

Golgi Apparatus of the Thyroid in Simple Goitre.—H. Okkels ("Appareil de Golgi des cellules thyroïdiennes dans le goitre basedowien," *Compt. rend. Soc. de Biol.*, 1931, **106**, 305–8, 3 text-figs.). The position of the Golgi apparatus in simple goitres varies: in some cells it is apical, in others basal, but there is always an increase in the size of the Golgi apparatus. G. M. F.

Observations on Human Spermatocytes.—J. Brontë Gatenby ("Note on Human Spermatic Cells Supravitally Stained in Neutral Red," *Anat. Rec.*, 1931, **48**, 121–9, 1 pl.). Human spermatocytes stained supravitally in pink neutral-red Ringer's solution are found to contain three categories of structures which take up the neutral red avidly: (*a*) the normal vacuolar system (vacuome); (*b*) needle-like crystals, usually from six to eight in number, practically always lying near the vacuome; (*c*) a peculiar vacuole with globules stuck on or in it. This last structure is not always present. It is assumed that the needle-like crystals are of the same nature as the Lubarsch crystals of the spermatogonia, and from the fact that they stain in neutral red, and both in the spermatogonia and Sertoli cells are best shown after chrome-osmium hæmatoxylin, it is presumed that they are of a lipin nature. Doubt is thrown on Montgomery's "Sertoli cell determinant

hypothesis," the development of Sertoli cells being regarded as fortuitously determined by position and relative stage of development of neighbouring cells. The figures of Montgomery purporting to be divisions or fragmentations of the crystals might just as well represent the formation of new crystals beside the old.

G. M. F.

The Effect of Phosphorized Olive Oil on the Development of Spermatocytes.—J. Brontë Gatenby ("Preliminary Report on the Effect of Phosphorized Olive Oil on the Spermatogenesis of *Abraxas grossulariata*," *J. Exp. Zool.*, 1931, **58**, 259–79, 4 pls., 1 text-fig.). By injecting phosphorized olive oil into the larvæ of *Abraxas grossulariata* at their final instar it is possible to bring about those processes which should normally take place in the spermatid, so that they occur in spermatocytes. As a result of the running together of a number of Golgi bodies in one part of the cell, relatively enormous acroblasts are produced. These acroblasts may grow considerably and then pass over whole to one of the daughter cells at mitosis, so that spermatids are formed containing very large whole acroblasts which are non-functional and which finally drift down the forming tails of otherwise normal spermatozoa. The acrosome of the Abraxas spermatozoon is purely the product of the Golgi bodies and is not due to activity on the part of the nucleus. In certain cases changes were observed in the mitochondria 11 to 16 hours after injection of the phosphorized oil. G. M. F.

Tissue Culture of Microglia.—I. Costero ("Estudio del comportamiento de la microglía cultivada 'in vitro.' Datos concernientes a su histogénesis," *Mem. de la real Soc. españ de Hist. nat.*, 1930, **14** (*Memoria II*), 123–82, 30 text-figs.). In this important monograph the characteristics of microglia cells as seen in tissue cultures are very fully described. The writer's observations show that "in vitro" it is possible to demonstrate all the forms, normal and abnormal, described by Río-Hortega. The cells are actively motile, phagocytic, and capable of emigrating for considerable distances from the cultures. The microglia cells frequently divide by direct division; mitotic figures have never been observed; development is quite independent of the pure neuroglia and of the ependymal epithelium, but is similar to that of the macrophages and monocytes. The microglia cells are mesodermal in origin, and are derived from cells which have taken up a position in the nervous tissue at a very early stage of embryonic development.

G. M. F.

The Chromosome Problem in Mammals.—F. A. Saez ("Estado actual del problema sobre los cromosomes de los mamifesos," *Conferencias y reseñas científicas de la real Soc. españ de Hist. nat.*, 1928, **2**, 1–11, 5 text-figs.). An interesting review of the evolution of chromosomes and their relation to sex in mammals.

G. M. F.

The Permeability of Arbacia Eggs.—D. R. Stewart ("The Permeability of the Arbacia Egg to Non-Electrolytes," *Biol. Bull.*, 1931, **60**, 152–70, 6 text-figs. II. The Permeability of the Arbacia Egg to Ammonium salts," *Biol. Bull.*, 1931, **60**, 171–8, 9 text-figs.). The general behaviour of Arbacia eggs to permeability by non-electrolytes agrees fairly closely with that of the plant cells studied by Overton and by Barlund, and to a somewhat less extent with that of the mammalian erythrocyte. No exception has been found to the principle that compounds which are freely lipin-soluble readily penetrate the Arbacia egg. In the case of substances which are only slightly lipin-soluble the size of the molecule appears to be of some importance. Following fertilization there is some evidence

of an increase in permeability to ethylene glycol. The rate of swelling of Arbacia eggs in solutions isosmotic with sea water of the ammonium salts of the first five saturated fatty acids has been found to be in the order: valerate > butyrate > propionate > acetate > formate. The rate of entrance of the acid rather than of the ammonia appears to be the limiting factor in determining the rate of swelling of the cell. G. M. F.

Observations on the Chromosomes of Certain South American Orthoptera during Spermatogenesis.—F. A. SAEZ ("Investigaciones sobre los cromosomas de algunos ortópteros de la América del sur. I. Número y organizacion de los complejos en cuatro géneros de acridios," *Rev. del Muses de la Plata*, 1930, **32**, 317–61, 11 pls.). A study of the chromosomes has been made during spermatogenesis in four species of South American acridians, the species selected being *Schistocerca paranensis* Burm., *Elæochlora viridicata* Serv., *Diedronotus discoideus* Serv., and *Chromacris miles* Drury. Each genus has its own peculiar cellular organization, which corresponds with its taxonomic position. G. M. F.

Tissue Cultures of Endothelial Cells.—TAKASHI SHIBUYA ("On the Pure Cultivation of Endothelial Cells from Aorta and their Differentiation," *Kitasato Arch. Exp. Med.*, 1931, **8**, 68–88). Portions of the endothelium of the ascending portion of the aorta were placed in a Ringer medium containing an emulsion of suprarenal capsule (exact strength and method of preparation not stated). It is claimed that a pure culture of endothelial cells was obtained. Subsequently, however, the endothelial cells underwent differentiation into fibroblasts, and lymphocyte-like cells. G. M. F.

Supravital Staining with Silver Ammonium Carbonate.—S. FARBER (*Am. J. Path.*, 1931, **7**, 131–8, 1 pl.). Silver ammonium carbonate may be used to mark living cells supravitally. By this means the origin of the monocytes is seen to be from the silver-marked portion of lymphoid tissue. The histiocytic tissue of the sinusoidal organs also reacts to supravital silver, but the response is unlike that of the monocytes. G. M. F.

Intestinal Adenoma in Swine.—H. E. BIESTER and L. H. SCHWARTZ (*Am. J. Path.*, 1931, **7**, 175–85, 3 pls.). In experimental and field cases of infectious enteritis in which extensive mucosal destruction occurred, epithelial proliferation originating in the remaining islands of injured cells was noted. These proliferating cells were flattened and elongated with large nuclei. They stretched out into the necrotic tissue in an attempt to cover the denuded tissue. An extensive destruction of mucosal tissue in two severe advanced cases of enteritis was associated with a degeneration of the epithelium and the formation of adenomatous growths.

G. M. F.

The Repair of Injuries to Bone in vitro.—J. S. F. NIVEN ("The Repair *in vitro* of Embryonic Skeletal Rudiments after Experimental Injury," *J. Path. & Bact.*, 1931, **34**, 307–24, 3 pls.). Fractures were produced in the embryonic long bones of fowls and mice, and the results studied in tissue culture. In 5-day long bone rudiments of the fowl, after the cartilaginous shaft has been cut through and the fragments have been brought into close apposition, complete repair rapidly occurs by proliferation of the chondroblasts. If the rudiments are fractured at a later stage, 7 days, when the formation of bone has begun, repair is effected, after restoration of continuity of the osteoblastic layer and fibrous periosteum has occurred, by the deposition of bone between the fragments. Here,

again, when there is an appreciable gap between the fragments, osteoblasts pass in and continue their histogenesis as in the $5\frac{1}{2}$-day rudiments. The cartilage does not participate in the process of local repair. When rudiments from 9-day embryos are fractured, the processes of repair are similar to those described for rudiments from 7-day embryos, except that the cells from the osteoblastic layer which fill up the gap between the cut surfaces bring about resorption of cartilage. The vulnerability increases and the power of regeneration of the cartilage cells decreases after about 5 days. The behaviour of Meckel's cartilage resembles that of the deeper layers of the developing epiphyseal cartilage of long bones.

G. M. F.

Intranuclear Inclusions in Poliomyelitis.—E. W. HURST ("The Occurrence of Intranuclear Inclusions in the Nerve Cells in Poliomyelitis," *J. Path. & Bact.*, 1931, **34**, 331–3, 1 pl.). The presence of acidophilic inclusions in the degenerating nerve cells of experimental poliomyelitis described by Covell (Proc. Soc. Exp. Biol. & Med., 1930, **27**, 927) is confirmed. The inclusions are much less numerous, smaller, and more difficult to stain electively than the inclusions of a similar type found in herpetic encephalitis and Borna disease.

G. M. F.

The Tonoplasm of the Endothelial Cells of the Placenta of Rodents.—I. COSTERO ("El tonoplasma de los endotelios en la placenta de los roedores," *Bol. de la real Soc. españ. de Hist. nat.*, 1931, **31**, 21–8, 2 text-figs.). The endothelial cells of the placenta of rodents possess a tonoplasmic fibrillary covering similar to that described by Río-Hortega and Jiménez-Asúa for the endothelial cells of other parts of the body. The particular features of the filamentous network are the regular sinuous arrangement of the fundamental threads, the lack of anastomoses, and divisions in the tonoplasmic filaments. The tonoplasmic fibres of the placental endothelial cells of rodents do not react to the stimuli which produce hypertrophic and hyperplasic proliferations in the corresponding formations of the decidual elements. G. M. F.

The Golgi Apparatus in the Red Cells of Some Amphibia and Reptilia.—S. KURASHIGE ("The Physiological Significance of the Golgi Substance in the Erythrocyte of Some Amphibia and Reptilia," *Folia Anat. Japonica*, 1930, **8**, 313–21). The Golgi apparatus in the erythrocytes of *Hynobius* and *Trionyx* was studied by the osmic method. The Golgi substance appears as a granule or short filament, and is formed by the transformation of what are termed Golgi specks which are seen lying round the nucleus. It is suggested that these specks are formed by the transformation of nucleolar substance which has been expelled from the nucleus. The Golgi substance turns into a special granular substance, which afterwards liquefies and is then expelled from the cell body. These granules are said to be equivalent to the so-called "segregation apparatus," and are nothing but a metabolic product. In the erythrocyte of the animals studied, the Golgi specks, the Golgi substance, and the granules are three continuous phases which lead to the metabolic product. This phenomenon is repeated in each cell at irregular intervals. G. M. F.

The Reproductive Cycle and Bird Migration.—W. ROWAN ("Experiments in Bird Migration. I. Manipulation of the Reproductive Cycle: Seasonal Histological Changes in the Gonads," *Proc. Boston Soc. Nat. Hist.*, 1929, **39**, 151–208, 11 pls.). The experiments here recorded show that by manipulating the lighting conditions the reproductive organs of the Junco (*Junco hyemalis connectens*

and several other species can be interrupted almost at will. Arrest of the normal spring recrudescence of the gonads and premature recrudescence in the middle of winter have been obtained, as well as reduction from this condition back to nearly the minimum in a period of six weeks. After the gonads have been brought from the winter minimum to the maximum in December, and reduced again to the minimum in February, they can again be brought to the maximum in May, thus attaining the maximum three times and the minimum twice within twelve months. Experimental birds and controls were liberated at intervals in winter, and their behaviour as regards migration noted. Subject to certain weather restrictions, a majority of those experimental birds, with their gonads either in a state of recrudescence or regression, will leave on gaining their freedom. Those that have attained the maximum or have remained at the minimum show no inclination to go, and are recaptured. There is thus a definite correlation between migration and changes in the gonads. G. M. F.

Osmotic Properties of the Erythrocyte.—M. H. Jacobs and A. K. Poupart ("Osmotic Properties of the Erythrocyte. II. The Influence of *p*H, Temperature and Oxygen Tension on Hemolysis by Hypotonic Solutions," *Biol. Bull.*, 1931, **60**, 95–119, 5 text-figs.). It is shown that *p*H changes of as little as 0·01 *p*H unit and temperature changes of as little as 0·5° C. may have a measurable effect upon the observed degree of hæmolysis. It follows, therefore, that "fragility" tests and other osmotic studies upon erythrocytes in which these factors are not properly controlled are of little value. G. M. F.

The Ætiology of Trachoma.—H. A. Reiman and A. Pillat ("Studies on the Etiology of Trachoma," *J. Exp. Med.*, 1931, **53**, 687–94). A bacillus closely corresponding with the description of *B. granulosis* Noguchi was isolated from one out of five typical cases of trachoma in Chinese. Inoculation of suspensions of this bacillus into the eyelids of *M. sinensis* monkeys produced scarring and contraction of the tarsal cartilages, with the development of conjunctival follicles in two out of five animals. G. M. F.

Arthropoda.

Insecta.

Californian Isoptera.—S. F. Light ("The Californian Species of the Genus *Amitermes silvestri* (*Isoptera*)," *Univ. Calif. Pub. Ento.*, 1930, **5**, no. 9, 173-202, 15 pls., 31 text-figs.). The large tropicopolitan genus *Amitermes silvestri* (family *Termitidæ*, order *Isoptera*) includes species with a very wide range of habits and habitats. A number of species of this genus range into the south-western United States, particularly into Texas, New Mexico, Arizona, and southern California. Here they are confined in large part to the desert or semi-desert regions, and form a characteristic element of the faunas of such areas. For this reason they have been designated Desert Termes by the author. Four species new to science are described, and in the present paper the author gives a full account of the morphology and life-histories of the species under consideration. M. E. M.

Tipulidæ from Eastern Asia.—C. T. Alexander ("New or Little-Known *Tipulidæ* from Eastern Asia (*Diptera*), VIII," *Philippine Journ. of Science*, 1930, **43**, no. 4, 507–36, 3 pls.). The crane-flies discussed in the present report are almost entirely from the mountains of Formosa, the majority being from Mount Hassen. As before, this extensive series of Tipulidæ was collected by Prof. Syuti Issiki, to whom the author expresses his thanks for the opportunity afforded of studying

these flies. Two species of *Dolichopeza* were taken in the mountains of Honshiu, Japan, and a few additional western species from China were received by the author from other collectors. In order to supplement our scanty knowledge of the distribution of the Formosan *Tipulidæ*, a complete list of the species from Hassensan, central Formosa, is included. A total of 25 species new to science is herein described. M. E. M.

Pupipara from the Philippine Islands.—G. F. Ferris ("Sixth Report on Diptera Pupipara from the Philippine Islands," *Philippine Journ. of Science*, 1930, **43**, no. 4, 537-53, 7 text-figs.). For the material upon which this sixth report is based, the author, as before, is chiefly indebted to Mr. R. C. McGregor. The object of the present paper is to present in these reports something approaching a review of the genera of the *Hippoboscidæ*, at least as far as this family is represented in the Philippine Islands. Consequently there is a departure in the present report from the procedure followed in the earlier papers in this series. Certain species that are not at present known from the Philippine Islands, but which may be reasonably assumed to occur there, are here included. M. E. M.

Morphology of Bark-Beetles.—K. E. Scheld ("Morphology of the Bark-Beetles of the Genus *Gnathotrichus* Eichh.," *Smithsonian Misc. Coll.*, 1931, **82**, no. 10, 1–88, Pub. no. 3068, 40 text-figs.). The author's present investigations are a tentative endeavour leading to a more intensive monograph of the genus *Gnathotrichus* Eichhoff. They have been carried out as a private study. This first paper covers the chitinous skeleton of the adult, pupa and larva, the structure of the digestive system, and the reproductive organs of the adult and larva. It is hoped later to publish two more papers, one on the sensory and secretory, the muscle structure, the respiratory, circulatory, and nervous systems of the larva and imago; the other on the metamorphosis and histological investigations. Whether or not a biological study will complete the work depends upon the time at the author's disposal. The study comprises only the North American species *Gnathotrichus materiarius* Fitch, *sulcatus* Lec., and *retusus* Lec. The necessary material—dried and mounted adults of the two western species *Gn. sulcatus* Lec. and *retusus* Lec.—was provided by the Dominion Entomological Branch from the Canadian National Collection in Ottawa. The adults were obtained elsewhere. Attempts to obtain larvæ and pupæ of the western species were unsuccessful, and therefore the discussions of the larval and pupal characters are based on material of *Gn. materiarius* Fitch only. A supplement on this account will be published subsequently as another paper. M. E. M.

Mexican Species of Isoptera.—S. F. Light ("The Mexican Species of *Amitermes silvestri (Isoptera),*" *Univ. Calif. Pub. Ento.*, 1930, **5**, no. 10, 215–32, 3 pls.). The present paper is based on the material collected during a recent trip into western Mexico for the Termite Investigations Committee. It includes descriptions of four new species of *Amitermes*, as well as a key to the soldiers of all the New World species of the genus from British Guiana northward, with the exception of two species, *A. confusus* Banks and *A. perplexus* Banks, which are based on alates only. A later paper will report the complete collection made in Mexico. In a previous paper by the author (1930) it was pointed out that the Nearctic species of *Amitermes* fall into apparently distinct groups on the basis of soldier characters. The 14 American species from the area under consideration may be referred to the five groups there suggested. With the additional species here described, it becomes possible to characterize these groups more or less completely as the author indicates in the present paper. M. E. M.

The New World Solenopsis.—W. S. Creighton ("The New World Species of the Genus Solenopsis (*Hymenop. Formicidæ*)," *Proc. Amer. Acad. of Arts & Sciences*, 1930, **66**, no. 2, 39–151, 8 pls.). Carlo Emery once characterized the genus *Solenopsis* as the *crux myrmecologorum*. That the term is apt, no one who has experienced the difficulties of the group will deny, least of all the author, who, at the end of three years of study, still finds the "cross" a heavy burden. At the inception of the work it was not realized that it would assume its present proportions. Its growth has necessitated constant restriction, but, even after lopping off all the Old World species, the bulk of the remainder is extremely unwieldy. It therefore seemed advisable, since the monograph can be divided into two parts, to publish these separately. The present paper presents an analysis of the species in the subgenera *Solenopsis*, *Euophthalma*, *Diagyne*, and *Œdaleocerus*. The subgenus *Diplorhoptrum* will be dealt with in a subsequent publication. M. E. M.

Sexual Organs of Bombyx mori L.—Y. Umeya ("III. Duplication of Sexual Organs in the Male Moth of *Bombyx mori* L.," *Proc. Imp. Acad., Tokyo*, 1930, **6**, no. 9, 371–4, 3 text-figs.). The present paper is a continuation of previous work on the degenerated motor muscles of penes in the Japanese bivoltine race. The author now describes two examples of duplication in both the internal and external sexual organs of *Bombyx mori*. L. M. E. M.

Trap Lantern Experiments in China.—C. Yuwa Wong ("Preliminary Report on the Trap Lantern Experiments," *Misc. Pub. Bureau of Entomology, Chekiang Province*, 1930, no. 4, 1–32, 3 pls., 1 chart, in Chinese). Experiments from 1924 to 1928, on the relative efficiency of electric and paraffin oil lights in lantern traps, proved conclusively the superiority of the electric illumination. *Pyralides* were found to constitute the largest part of the trap captives. The next largest part consisted of miscellaneous moths, and the remainder was made up of beetles and midges. Nineteen separate species of destructive insects were represented, and it was found that high atmospheric temperatures greatly increased the nightly total of insects captured. Most of the *Pyralides* were captured between the hours of 7 to 11 p.m., and the first of the species showed itself in early April, while the last disappeared about the middle of October. M. E. M.

The Mulberry Tree Pest.—J. T. Chu ("*Rondotia menciana*, the Mulberry Tree Pest," *Misc. Pub. Bureau of Entomology, Chekiang Province*, 1930, no. 2, 1–44, 4 pls., 1 text-fig., in Chinese). *Rondotia menciana* has two generations in the course of the year, covering from June to September. The moths disperse from the fields where they emerge from the pupæ, apparently in search of suitable places for oviposition. The female moths lay an average of 200 eggs each, in masses of two to four layers, and those of the first generation are laid on the bark of the trunk of the mulberry tree and are covered with down, from the body of the parent, as a winter protective covering. But those of the second generation are never down-clad. The larvæ are gregarious at first, but disperse very soon. Dispersal of caterpillars in the later stages is forced by their cannibalistic habits. They feed on the mulberry tree only, and never upon other plants. Climate exerts a very important influence upon the eggs and the larvæ of *Rondotia*. Unusually low temperatures appear to be unfavourable to the over-wintering eggs. The frequency of rains and heavy fogs has an important bearing on the development of the caterpillars. The author succeeded in rearing four species of parasites. Outbreaks of the *Rondotia menciana* are due to the migrating habits and the egg-laying habits of the moths. The moths seek the trees with plenty of leaves for oviposition, and when this condition is available in localities where large numbers of moths are flying, the

latter may concentrate in the particular fields where the required trees are available. In such cases very large numbers of caterpillars are produced, and the whole foliage may be destroyed. This is a contingency particularly likely to occur in early autumn. M. E. M.

The Chinese Armour Weevil.—Ming-Tao Jen ("*Hispa armigera*, the Armour Weevil," *Misc. Pub. Bureau of Entomology, Chekiang Province,* 1930, no. 3, 1–51, 6 tables, 1 map, in Chinese). The armour weevil, *Hispa armigera* Olives, is one of the most destructive rice insects in the Chekiang Province of China. In 1925 the damage caused by this insect was prevalent over a large area in the south-eastern part of the Province, and numerous reports relating to its outbreaks were received at the Bureau of Entomology. Mr. K. Y. Fey, the founder and former director of the Bureau, prepared a small pamphlet in 1925, indicating how to control insects, and the measures he advocated gave successful results. The present paper is the first publication on the life-history of the species in China. The study was carried out in Wenchow sub-station of the Bureau, under the supervision of Mr. Y. Hsuwen Csou, the Director, and Mr. K. Y. Fey, the Chief Entomologist, from 1928-1930. It has been found that three or four generations of the armour weevils occur annually in nature, but that from five to six generations may be produced in the laboratory. Over-wintering takes place in the adult stage, and resumption of activity occurs early in the spring, when young buds and foliage of the *Gramineæ* are selected as food. Copulation takes place shortly after the termination of the hibernation phase, and oviposition commences within 57 to 168 hours after the development of the rice foliage. The number of eggs oviposited by the females ranges from 22–226. The first generation commonly covers the period from about April 15 to June 15, and the remaining generations follow one another every 22–26 days, until late August. The mortality of the adult is much higher in winter than in summer.
M. E. M.

Rice Insects in China.—Jen-Chieh Lou ("The First Report of the Rice Insects of Lanchi District," *Misc. Pub. Bureau of Entomology, Chekiang Province,* 1930, no. 5, 30, 10 text-figs., 1 map, in Chinese). The present paper is an attempt to afford a general survey of the pests found in the rice fields of this district, in order to determine what control methods can be effectively applied to these insects. According to the author's field observations in the district, 14 species of insects are believed to be particularly destructive to the crop. The names of these species are as follows :—*Schœnobius incertellus* Walk., *Shilo simplex* Butl., *Nonagris inferens* Walk., different species of *Fulgoridæ*, different species of *Jassidæ*, *Nephotrix apicalis* Matsch., *Ciea dula masatonis* Mats., *Deltocephalus darsalis* Matsch., *Lema melamopa* Linnæus, *Naranga diffusa* Uh., *Cnaphalo crocis* Medinalis Ginen, *Parana guttatus* Brem., *Aenania Lewisi* Scott., *Oxya velox* Fabr. M. E. M.

Notes on the Philippine Rutilinæ.—F. Chaus ("VI. Nachtrag zur Kenntniss der Philippinischen Ruteliden (*Coleoptera, Lamellicornia*)," *Philippine Journ. of Science,* 1930, **43**, no. 4, 555–9, 4 text-figs.). The following four species new to science are described :—*Popillia furcula* n.sp., *Anomala muricata* n.sp., *Anomala nocturna* n.sp., *Euchlora nerissa* n.sp. M. E. M.

Australian Elateridæ.—A. H. Elston ("Results of Dr. E. Mjöberg's Swedish Expeditions to Australia, 1910–1913. 50. *Elateridæ*," *Arkiv. för Zoologi,* 1931, **22**, 1, no. 1, 1–22). This paper consists of an annotated list of the species captured during the expedition, many of the species being new to science.
M. E. M.

South and Central American Hemiptera.—D. MELIN ("Hemiptera from South and Central America, II," *Arkiv. för Zoologi*, 1931, **22**, 1, no. 2, 1–40, 7 pls.). This paper is similarly an account of the species collected on the expedition by the author and Dr. Roman during their travels in the tropical part of South America, contrasted with the species already represented in the Museum of Natural History in Stockholm, which have, to a great extent, been previously determined by Prof. Handlirsch of Vienna. M. E. M.

New Species of Neuroptera.—R. P. LONGINUS NAVÁS ("Insecta Nova," *Mem. della Pont. Accad. delle Scienze—I Nuovi Lincei*, 1930, serie II, **14**, 409–18, 2 text-figs.). The author describes the following new species:—Family *Myrmeleonidæ Nasma* nov. gen., *Nasma coreana* n.sp.; Family *Chrysopidæ: Chrysopa solaria* n.sp.; Family *Mantispidæ: Manega* nov. gen., *Manega luddemanni* n.sp., *Nivella* nov. gen., *Nivella rubella* n.sp., *Necyla paolina* n.sp.; *Mecoptera*—Family *Panorpidæ: Neopanorpa Harmandi* nov. var. *conjuncta* nov.; *Trichoptera*—Family *Leptoceridæ: Honilia pallida* n.sp. M. E. M.

The Petroleum Fly.—W. H. THORPE ("The Biology of the Petroleum Fly (*Psilopa petrolii* Coq.," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 331–44, 2 pls., 4 text-figs.). As the author states, "The Petroleum Fly is undoubtedly one of the chief biological curiosities of the world." The larvæ of this remarkable fly inhabit the small pools of crude petroleum in the oil-fields of California which are formed either by natural seepage or by overflows from the pipe-lines. In the present paper a most interesting account is given of the habits and developmental stages of *Psilopa petroli* (*petrolii*). The larvæ breathe by means of long siphons which are extended to the surface-film of the shallow oil pool, and the chitinous integument completely protects the underlying tissues from contact with the oil. Nevertherless, it has been found that the larvæ, in the process of feeding on the bodies of other insects accidentally drowned in the oil, swallow the crude oil with impunity. When about to pupate, the larvæ crawl from the oil pool and pupate attached to adjacent grass stems. The adult female is able to settle on the oil surface for the purpose of laying her eggs, but in this position she is precariously situated, and a gust of wind often results in her death by submersion in the oil, where she is then consumed by the larvæ of her own species. This paper should be read by all who are interested in entomology—or, for that matter, biology generally—as *Psilopsa petroli* is an astounding example of Nature's powers of adaptation. M. E. M.

Synonymic List of Oriental Dragon-flies.—F. F. LAIDLAW ("A Synonymic List of Dragon-flies of the Family *Gomphidæ* (*Odonata, Anisoptera*) found in the Oriental Regions," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 171–97). The list is intended to include all *Gomphidæ* recorded from the Oriental region. For the present purpose the author defines the limits of the region as follows:—To the north, the latitude of Shanghai (about 31′ N.), excluding any part of Japan; to the west, the politic frontier of British India. To the south and east the Oriental *Gomphidæ* have settled the matter for themselves; they do not appear to have extended their range beyond "Wallace's line," except for one or two species found in the Celebes. These limits are admitted to be abitrary. M. E. M.

Scent Glands of Certain Heteroptera.—M. D. H. BRINDLEY ("On the Metasternal Scent Glands of Certain *Heteroptera*," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 199–208, 1 pl., 4 text-figs.). In 1929 the present writer described the scent apparatus in *Corixa*; and arising out of that investigation the metasternal

glands of other families of bugs have been examined to determine what variation in these organs occurs within the group, and whether it can throw any light on the relationship and phylogeny of the *Heteroptera*. The available material was somewhat scanty, and, so far, it has not been possible to obtain examples of many important families and subfamilies. A general account of the structure of these glands is provided, and the author then compares and makes comments on the structure of the same organs in 17 related families. M. E. M.

The Biology of Rhodnius prolixus.—P. A. BUXTON ("The Biology of the Blood-Sucking Bug, *Rhodnius prolixus*," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 227–36, 1 text-fig.). The present investigations have been carried out with a strain of *Rhodnius prolixus* which has been in captivity for at least ten years: it was originally sent to London by Prof. E. Brumpt. An interesting account is given of the development of the egg, larva, and the adult. The number of eggs laid by the female has been studied, together with the percentage and rate of hatching of 318 eggs. In regard to the larvæ, the rate of development, the number of ecdyses, and the amount of blood taken at successive meals are recorded. The adult has been studied from a number of separate aspects—the mean weights of unfed and fed insects; the survival periods of starved males and females; egg-laying; the fertilization of the female; the relation between fertility and feeding in both males and females; and the correlated effect upon oviposition and the number of eggs laid, etc. The author concludes his paper with a summary and discussion of the investigations carried out. M. E. M.

New Oriental Insects.—R. P. LONGINUS NAVÁS ("Insecta Orientalia," *Mem. della Pont. Accad. delle Scienze—I Nuovi Lincei*, 1930, serie II, **14**, 419–34, 7 text-figs.). The following genera and species are described as new:—*Neuroptera*—Family *Myrmeleonidæ*: *Negrokus* gen. nov., *Negrokus lebasi* sp. nov.; Family *Hemerobiidæ*: *Notiobiella khandalensis* sp. nov.; Family *Chrysopidæ*: *Cintameva benaveenti* sp. nov., *Ancylopteryx 8-punctata* P. var. *salai* nov. Viridis; Family *Mantispidæ*: *Climaciella regia* sp. nov.; *Megaloptera*—Family *Chauliodidæ*: *Neuchauliodes sinensis* Walk. var. *formosensis* nov.; *Mecoptera*—Family *Ponorpidæ*: *Panorpa lachlani* sp. nov., *Neopanorpa formosensis* sp. nov.; *Plecoptera*—Family *Perlidæ*: *Neoperla tristis* sp. nov.; *Ephemeroptera*—Family *Ephemeridæ*: *Ephemera javana* sp. nov. M. E. M.

New Trichoptera and Plecoptera.—M. E. MOSELY ("New European *Trichoptera* and *Plecoptera*," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 237–53, 1 pl., 33 text-figs.). During the past eight or nine years excursions on the Continent, devoted almost exclusively to the collection of *Trichoptera* and *Plecoptera*, have resulted in the accumulation of a mass of material, none of which has hitherto been recorded. It is to be expected that, when intensive collecting is carried out in little-known orders, new species will be found, and the author's experience has proved this to be the case. A trip to Corsica resulted in the discovery of 20 new *Trichoptera* and 5 *Plecoptera*. The *Trichoptera* have already been considered in a paper published in *Eos*, Madrid, during the past year. The description of a new genus of the *Trichoptera*, discovered at Cagnes, in the South of France, has appeared in the Annals and Magazine of Natural History. Remaining undescribed are a few Continental and one new British species, which the author here describes with a view to clearing the way for a complete record of these thrips. M. E. M.

Greenland Species of Anthomyidæ.—J. E. COLLIN ("A Revision of the Greenland Species of the Anthomyid Genus *Limonphora* Sens. Lat. (*Diptera*), with

Figures of the Male Genitalia of These and Many Other Palæarctic Species," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 255–82, 13 pls.). The title is self-explanatory of the contents of this paper. M. E. M.

The Burrow-Stocking Habits of Wasps.—G. D. H. Carpenter (" *Psammocharidæ* (*Pompilidæ*) and *Sphecidæ*. Collected Records of their Different Methods of Filling-in the Stocked Burrow," *Trans. Ento. Soc., London*, 1930, **78**, pt. 2, 283–308). The author summarises his paper as follows :—The conclusion that, when filling up their stocked burrows, wasps of the family *Psammocharidæ* ram the loose earth down with their abdomen never using the head, while *Sphecidæ* use the head, and never the abdomen, has been firmly established by records of 28 observations on 25 species of Psammocharids by 9 authors, and of 46 observations on 31 species of *Sphecids* by 21 authors. Suggestive lines of inquiry among *Vespoidea* are opened up by the records of certain cell-making Psammocharids, and among *Apidæ* by certain Sphecids. Two observations on *Bembecidæ* show that they, like Psammocharids, use the abdomen when finally closing the burrow, while *Larridæ*, though in certain respects resembling Sphecids, are in their habits more like Psammocharids. A single observation on a species of *Scoliidæ* shows that it uses its abdomen like a Psammocharid, but also introduces material with its mandibles like a Sphecid. More observations on these last three families would be of great interest. It is shown how the specialized use of the abdomen as a hammer could have arisen by easy stages, and how the use of a stone as a hammer could have gradually developed. M. E. M.

New Hymenoptera and Coleoptera. (" Entomologische Ergebnisse der Deutsch-Russischen Alai-Pamir-Expedition, 1928, (II)," *Mitteil. aus dem Zool. Mus. in Berlin*, 1930, **16**, 6, 823–917). The material obtained by the Expedition is described and discussed separately by the following collaborators : J. D. Alfken—*Hymenoptera* IV. (*Apidæ*, partim) ; H. Hedicke—*Hymenoptera* V. (*Apidæ*, genus *Anthophora* Latr.) ; N. Mallach—*Hymenoptera* VI. (*Tenthredinidæ*) ; H. Bischoff —*Hymenoptera* VII. (*Hummelnester*.) ; W. F. Reinig—*Coleoptera* II. (*Tenebrionidæ*). M. E. M.

African Acrididæ.—W. Ramme (" Ergänzungen und Berichtigungen zu meiner Arbeit " Afrikanische Acrididæ " (Orth.)," *Mitteil. aus dem Zool. Mus. in Berlin*, 1930, **16**, 6, 918–45, 1 pl., 17 text-figs.). The author here gives complementary descriptions to those in his earlier work, several genera and species herein described being new. M. E. M.

Arachnida.

The Anatomy of the Intestines of Spiders.—J. Millet (" Anatomie comparée de l'intestin moyen céphalo-thoracique chez les araignées vraies," *C. R. des Séances de l'Acad. des Sci.*, 1931, **192**, no. 6, 375–7, 1 text-fig.). After studying a large number of different spiders, the author states that he definitely disagrees with previous writers who state that the anatomy of the mid-intestine conforms to a uniform pattern. The result of the present studies is to show that there are, in the author's opinion, four distinct types of structure, namely " simple type," represented in the Dysdérides, Sicariides, Pholcides and in certain Théridiides ; " intermediary type," represented in the Dictynides and in the greater part of the Théridiides ; " classical type," represented by what has previously been recognized as the uniform pattern ; and the " complex type," represented in certain Salticides, Epeirides and Erésides. The author points out that between these four types there are transitional forms. M. E. M.

New Scorpions from Natal.—J. Hewitt (" A New Subspecies of Scorpion from Natal, *Ann. Natal Mus.*, 1931, **6**, pt. 3, 459–60, 1 text-fig.). The essential characters of the subspecies is in the dentition of the movable finger, which has two continuous rows of granular teeth. The subsidiary row, which includes the isolated larger granules of an ordinary Cheloctonus, extends from the apex of the digit to the highest point of the basal prominence. In this row the larger granules are not very prominent, although larger than the intervening granules. On the immovable finger only one continuous row is present; the subsidiary row includes only the usual six or seven large isolated granular teeth. A distinct shallow sinus at the base of the immovable finger, and well-marked low lobe at the base of the movable finger; this is in the adult female. The author gives other morphological differences, with the measurements of the adult female, whose colouration is stated to be blackish throughout, except for the vesicle and cheliceræ, which have a chestnut tinge. The name of this new subspecies is *Cheloctonus anthracinus* Pocock *warreni* subsp. nov.; its special interest lies in its direct connection with *Opisthacanthus* and the other ischnurine genera. Thus in this primitive genus *warreni*, more than any other species, shows both scorpionine and ischnurine characters in the dentition of its palps. M. E. M.

Multiple Origin of Spermatozoa.—E. Warren (" The Multiple Origin of Spermatozoa from Spermatids in Certain South African Spiders," *Ann. Natal Mus.*, 1931, **6**, pt. 3, 451–8, 1 pl.). The object of the author has not been to describe the origin of the spermatids—that is, whether or not they are derived from a typical series of karyokinetic divisions—but to describe the developmental processes which result in the production from a lobule of 40 spermatids of about 80 spermatozoa. The theoretical bearing of this remarkable phenomenon of the multiple origin of the spermatozoa on the chromosome hypothesis of heredity is so drastic that it will lead some cytologists to doubt the validity of the observations. In that event the author asks how the regular association of the chromatin threads in pairs can be accounted for in any other way than by the splitting of the spermatic cords, even if we omit the intermediate stages of splitting. The author advances other arguments in support of his hypothesis, and makes the following subsequent conclusions. With such a mode of division any mathematically correct subdivision of the chromatin elements would appear to be quite impossible. Further, it must be noted that every part of the process is subject to the greatest variation. The size of the young spermatid, the amount of stainable chromatin in it, the size of the karyosome, the fibrous structure of the spermatic cords, the length and width of the cords, the length and thickness of the chromatin threads and the size of the encapsuled spermatozoa, are all liable to vary very widely and often independently of one another. It is difficult to see how the current elaborate hypothesis of chromosome architecture can be reconciled with such observations as are here presented. M. E. M.

Nemathelminthes.

Nematoda.

Nematodes of the Genus Rhigonema Cobb, 1898, and Dudekemia n. gen.—Paulo Artigas (*Mem. Inst. Oswaldo Cruz*, 1930, **24**, 19–30, 7 pls.). After general discussion of the group, the author proposes the substitution of the family Isakidæ by Rhygonemidæ, a name derived from the genus containing the type species of the group, i.e., *R. infecta* Leidy, 1849. The family, which is defined, is divided into two subfamilies, the Ichthyocephalinæ, containing the single genus

Ichthyocephalus, and the Rhigoneminæ, containing the genera Rhigonema and Dudekemia n. gen. Six species of the latter, from the intestine of myriapods, are described, three of which are new. J. L.

Nematode Parasites of Pigs in Bengal.—H. P. A. MAPLESTONE (*Rec. Ind. Mus.*, 1930, **32**, 77–105). The 15 species of helminths described and figured in this paper were collected from the intestines of 44 pigs slaughtered in Calcutta abattoirs. One species of Cruzia and two of Œsophagostoma are new to science. The author draws attention to the fact that only one specimen of *Ascaris lumbricoides* was found in all the intestines examined, though known to be common in pigs in Bengal, so it is probable that other rarer parasites have been missed, and the list should not be taken as a comprehensive one. J. L.

A New Genus of Nematode Clementeia and a New Species C. clementei, a Parasite of Julids.—PAULO ARTIGAS (*Mem. Inst. Oswaldo Cruz*, 1930, **24**, 31–4, 1 pl.). The new genus and species *Clementeia clementei*, here described and figured, was obtained from the intestinal tract of myriapods from Rio de Janeiro. J. L.

Platyhelminthes.

Cestoda.

The Introduction and Spread of the Fish Tapeworm (Diphyllobothrium latum) in the United States.—HENRY B. WARD (*De Lamar Lectures*, 1929–30, 1–36, 1 pl.). Although tapeworms were recognized and described as early as 1550 B.C., the first recorded case of broad tapeworm infection was from the lake region of northern Switzerland in 1592. The broad tapeworm had always been of interest, and a subject of research, on account of its reputation as the cause of a type of pernicious anæmia in human beings, both in the Old World and in America. Its structure, life-history, distribution and clinical significance were thoroughly worked out in Europe during the latter part of the last century. The parasite was first reported in America by Warthin, in Michigan, in 1895, from hospitals connected with mines. Warthin predicted that the parasite would become endemic in Upper Michigan, as all the conditions in the mining towns inhabited by infected Finns and Swedes were favourable to infection of fish in the lakes and rivers. He also noted the possible infestation of cats and dogs. The native human cases occurring in North America appeared to originate from infected immigrants from the Baltic lands. Such immigrants settled in mining districts, where medical treatment was limited and community hygiene primitive, and they contaminated the water of lakes and rivers, in which suitable intermediate hosts were numerous. Research had resulted in the discovery of the crustacean and fish intermediate hosts, the latter being numerous species of food fish, including the wall-eye, pike, yellow perch and burbot. Man, however, was not the only source of infection of the secondary intermediate hosts. It was becoming recognized that many wild and domesticated carnivora acted as reservoirs of the adult parasite. Among these the fox, bear, dog, and cat served to distribute ova more widely and uniformly than man, and maintained a constant infection. The chief sources of infected fish were the lakes. Thus a belt of infection stretched across the great lakes, including the Upper Mississippi basin and extending out into Iowa and possibly Nebraska, crossing into Manitoba, and embracing lakes almost into the Rocky Mountains and far into the north country. As well as by environmental conditions, human infestation was favoured by such contributing factors as food habits, race, sex, and age. Conditions essential to the establishment of an endemic

area were: a susceptible area, i.e., freshwater lakes and streams containing abundance of primary and secondary intermediate hosts; a population naturally in contact with fish; the habit of eating uncooked fish; the practice of discharging raw sewage into lakes and rivers. J. L.

Trematoda.

Studies on the Trematode Family Strigeidæ (Holostomidæ), 20. Paradiplostomum ptychocheilus (Faust).—J. P. VAN HAITSMA (*Trans. Amer. Micr. Soc.*, 1930, **49**, 140–53, 2 pls.). The specimens from which this new adult species was described were obtained from ducks, *Mergus americanus*, *Lophodytes cucullatus*, and *Harelda hyemalis*. Feeding experiments showed that *Neascus ptychocheilus* (Faust), which developed in the peritoneum and mesentery of the minnow, was the metacercaria of this new parasite. The diagnosis of the genus Crocodilicola Poche, 1921, is emended. J. L.

Notes on the Genus Opisthoglyphe Looss, 1897, and Allied Genera.—LAURO TRAVASSOS (*Mem. Inst. Oswaldo Cruz*, 1930, **24**, 1–18, 7 pls.). Hitherto four genera of Trematodes have been described from Australia as parasites of Batrachians: Opisthoglyphe, 5 species; Dolichosaccus, 6 species; Brachysaccus, 2 species; and Rudolphiella, 1 species. The author considers Brachysaccus synonymous with Opisthoglyphe, or, at most, a subspecies of this, and includes the two species of the former with his list of Opisthoglyphe. *Opisthoglyphe locellus* Kossack, 1910, is placed in the list provisionally. The various species of the three genera are described and illustrated. J. L.

Studies on the Trematode Family Strigeidæ (Holostomidæ). Life-Cycle and Description of the Cercaria of Cotylurus michiganensis (La Rue).—J. P. VAN HAITSMA (*Journ. Parasitol.*, 1930, **16**, 224–30). Tetracotyles from around the hearts of *Catostomus commersonii* fed to young herring gulls produced a heavy infection of adult *Cotylurus michiganensis* (La Rue) in the bursæ Fabricii of these gulls. The eggs developed miracidia in about three weeks. On exposure to snails, only two specimens of *L. emarginata* became infested, and these produced cercaria 40 days later. J. L.

The Life-History of Two North American Frog Lung Flukes.—WENDELL KRULL (*Journ. Parasitol.*, 1930, **16**, 207–12). *Pneumonœces medioplexus* Stafford, from *Rana pipiens*, undergoes its developmental stages first in the snail *Planorbula armigera*, and secondly in dragon-flies of the genus Sympetrium, while those of *Pneumonœces parviplexus*, from *Rana clamitans*, occur in the snail *Gyraulus parvus* and dragon-flies of the genus Sympetrum. Otherwise the life-histories are similar. The eggs which pass out into the lungs of the frog are swallowed and pass out with the fæces, being fully mature when passed. They hatch only on feeding to the snails. The cercaria (Xyphidocercaria) pass out and enter the respiratory organs of dragon-fly nymphs, where they encyst and become infective after six days. There they remain till the dragon-fly becomes adult and is eaten by a frog, when they migrate, via the œsophagus, to the mouth, and so reach the lungs. J. L.

Trematode Parasites of Philippine Vertebrates, 2. Two Echinostome Flukes from Rats.—MARCUS A. TUBANGUI (*Phil. Journ. Sci.*, 1931, **44**, 273–83, 2 pls.). *Euparyphium ilocanum*, first recorded in native Filipinos, is here described from *Mus norvegicus*, showing that rats may assist in the dissemination of this species. A new species, *Euparyphium guerrerei*, is also described from the same host. Both species are figured. J. L.

The Anatomy of the Trematode Macrophyllida antarctica (Hughes.) —T. HARVEY JOHNSTON (*Australian Journ. Exper. Biol. & Med. Sci.*, 1930, **7**, 101–7). After re-examination of the material, the author gives a detailed and somewhat emended account of the new genus and species described by Miss Hughes, *Macrophylla antarctica* (*Macrophyllida antarctica*), from the gills of a shark, *Mustelus antarcticus*. He places the genus provisionally in the subfamily Capsalinæ.

J. L.

A New Species of Trematode of the Genus Anoplodiscus.—T. HARVEY JOHNSTON (*Australian Journ. Exper. Biol. & Med. Sci.*, 1930, **7**, 108–12). The description and illustration of this species were made from a single specimen obtained from the fin of a black bream, *Sparus australis*, from Sydney Harbour.

J. L.

Rotifera.

Research and Other Work among Rotifera.—P. DE BEAUCHAMP ("Coup d'œil sur les recherches récentes relatives aux rotifères et sur les méthodes qui leur sont applicables," *Bull. Biol. France et Belg.*, 1928, **62**, 51–125, 282, 2 text-figs.). In this most informative paper the author summarizes and comments upon the laboratory and other research work carried out and reported upon during the preceding 20 years and having reference to the class Rotifera. It is impossible to give here more than a few of the principal headings under which the various researches are dealt with. While special studies under laboratory conditions provide the greater part of the subject-matter, the more important of the faunistic work achieved by the field investigators is also brought into the picture presented to the scientific reader. Under the heading of "Morphology and Morphogeny" are noticed the determination by Martini (1912) and the confirmation by Nachtwey (1926) of the constancy of the cellular elements in the individual rotifers of the same species, and the descriptions of the embryology of species of Asplanchna by Tannreuther (1920) and by Nachtwey in the paper already cited. Passing to the cytology of reproduction, one finds references to the heterogeny of rotifers, to the existence—at least in certain species—of two distinct kinds of females, for which Storch has suggested the names "Amictic" and "Mictic," respectively those incapable and those capable of fecundation. Both kinds of females produce eggs; but whereas from parthenogenetically developed and speedily hatching eggs of the amictic female emerge only females of the same type, from the similarly parthenogenetically developed and quickly hatching eggs of the mictic female, if not fecundated, emerge males; whilst, if fecundated, the same females produce the so-called resting eggs, which, in due course and after a long interval, hatch out amictic females, whose progeny may be females of either description. These facts lead on to the nature of spermatogenesis, whereunder, after referring to the studies of Illgen (1914 and 1916) on the spermatozoid in the aberrant Order of the Seisonacea, he discusses the papers by Whitney (1917 and 1918), in which are demonstrated the existence in certain Ploima of two kinds of spermatozoids. Under oogenesis of different kinds of eggs is mentioned Whitney's confirmation (1909) of Lenssen's assertion that the impregnatable, or male, egg is, in fact, haploid, the mictic egg diploid. Also the results of the careful study by Storch (1924) of *Asplanchna priodonta*, wherein is described the oocyte of the amictic female as having in its earlier stages some membranous bodies adhering externally to the nucleus, but dissolving away before maturity of the latter, whilst the nucleus of the unfecundated mictic egg has no such membranous body attached, or very little. The somewhat different results attained by Tauson (1924) are set forth, and

reference made to Lehminsick's description (1926) of the nuclei of the two kinds of eggs in *Synchæta pectinata* and *Euchlanis triquetra*. In the third chapter are reflections on methods of work in use for the study of determination of sexuality or of variation, which includes a great many topics, such as purity of cultures, special foods, etc., and permits references to works by Lunz, Chatton, Treillard, Mitchell, Noyes and others, of much interest. Succeeding chapters are devoted to a discussion of experimental research in the study of the mode of reproduction and of variation, seasonal and otherwise, whilst the remaining pages deal with the faunistic topics of distribution, classification, phylogeny, nomenclature, systematic revisions and the validity of the old orders. D. L. B.

A Secondary Method of Digestion among Rotifers.—A. Remane (Kiel) ("Intrazelluläre Verdauung bei Rädertieren," *Ziets. wiss. Biol., Abt. C.*, 1929, **2**, 146–54, 4 text-figs.). "Extra-cellular digestion is typical for rotifers. In multitudinous instances the food within the richly ciliated stomach does not come into contact with the wall of the stomach at all, and almost universally there are present gastric glands, purely secretive in function, which empty their product into the cavity of the stomach." One may thus translate the opening sentences of the author. They describe the normal digestive process of rotifers in general, or, as it is called, "extra-cellular digestion," i.e., digestion within the cavity of the stomach, the cells in question being the syncytial cells of the wall enclosing the stomach cavity. He proceeds to give a list of over 20 species which he thinks there are grounds to believe to be endowed with intra-cellular digestion, i.e., digestion within the actual stomach-wall. These species do not form a group, as they are not, all of them, of close relationship systematically. Each one possesses a highly developed mastax, adapted either for pumping or for seizing action, and in each are found, either in the body cavity or actually in the stomach-wall itself, certain organic bodies of chloropast- or chlorella-like structure of greenish or brownish colour. They are, in short, those rotifers which have been latterly regarded as hosts for Zoo-Chlorellæ. In 1909 de Beauchamp, having specially studied such inclusions in *Itura aurita*, regarded them as of symbiotic character, and added that in *Dicranophorus caudatus, Encentrum saundersiœ* and *Ascomorpha ecaudis* the phenomena are exactly the same. The author thought that this view was in conflict with observations made by Lauterborn in 1894, and later, when several green or golden-brown organisms had been found in the rotifers *Chromogaster testudo* and *Gastropus stylifer*. Lauterborn had concluded that the brown bodies arose from the green, which had been recognized as chromatophores of Dinoflagellatæ, and suggested that some sort of symbiosis might be partly involved. Believing that the facts pointed rather to the presence of intra-cellular digestion, the author set on foot a series of examinations of specimens of *Ascomorpha ecaudis*, a fairly close relative of *Chromogaster testudo* and one of the rotifers examined by de Beauchamp. His initial examinations of specimens from two localities (one visited twice at an interval of six weeks) gave results similar to those of Lauterborn in that in each of the gatherings rotifers were found in whose stomach-wall were present several different kinds of organisms, but otherwise remarkable in that, while the several specimens from any one gathering gave similar results, these differed in the constituent organisms and their relative frequence from the results of specimens from the other gatherings. Later experiments were made by culture methods, first by feeding the rotifers on filtered water from their habitat, afterwards by feeding them on special food, viz., on Paramecium and Colpidia in the first place, and on one of the lower Algæ, a species of Carteria, later, the latter giving better results. In specimens from the cultures examples were found which, beside the

organisms, had some vacuoles within the stomach-wall, and whilst in some cases these vacuoles were empty, in others they enclosed similar organisms and clots, large or small, of brown conglomerate (considered to be the undigested refuse of food). Without going further into the details given of the various inclusions, etc., these results satisfied the author that in *Ascomorpha ecaudis* the existence of intra-cellular digestion had been absolutely proved. He continued his investigations upon others of the rotifers he has listed. It is noteworthy that in many species the harbouring of the supposed Zoo-chlorellen is accompanied by modifications of the normal structures of the digestive system. As many of the rotifers named by him are among the commonest in British habitats, there is here a subject of most interesting and important nature, which can be investigated with comparative ease. The author summarizes his conclusions as follows :—(1) The green inclusions of the stomach-wall of *Ascomorpha ecaudis* are not, at least, as regards the majority, Zoo-chlorellæ. They differ according to locality and time of year. (2) It was established, by food experiments, that the green inclusions arose from the food, and that Ascomorpha possesses intra-cellular digestion. (3) Among rotifers intra-cellular digestion occurs almost certainly in the genera Gastropus and Chromogaster, as well as in the species *Encentrum rousseleti* and *E. villosum*. For other species it is probable. (4) Intra-cellular digestion among rotifera is a secondary development from extra-cellular. As accompanying appearances of this transformation may be given—the growth of the lobular enlargements of the stomach and of its muscles, the syncytial structure of the intestinal wall. D. L. B.

A New Rotifer Parasitic on a Hydroid Polyp.—A. REMANE (Kiel) (" *Proales gonothyræa* n. sp., ein an Hydroidpolypen parasitierendes Rädertier (7. Beitrag zur Fauna der Kieler Bucht."), *Zool. Anz.*, 1929, **80**, 289–95, 3 text-figs.). An interesting addition to the list of Rotifera addicted to one form or other of parasitic existence has been made by the author, who has discovered in colonies of the hydroid polyp *Gonothyræa loveni* Allman, established on the piles of the Schilksee Bridge (Kieler Bucht), a new ecto-parasitic rotifer, which is to be found at all seasons of the year attached by its head to the exterior of the individual polyp, mostly a little below the bases of the tentacles and within the case which protects the central portion of its host. While its general form and structure, as well as its habit of life, conform to the generic type, it is characterized by several more or less important deviations therefrom. It can creep or glide, by the action of the cilia on the ventral side of the head, over any firm surface, but is quite unable to swim through open water ; it has two frontal eyes closely adjacent ; its jaws are of the cardate type, adapted for pumping action, and its eggs are flattened on one side, and by this flattened side they adhere where they are laid, mostly on the inner side of the case of the polyp. A very full description with excellent figures is provided for this newest-discovered parasite. D. L. B.

New or Rare Rotifers in Germany.—J. HAUER (Carlsruhe) (" Zur Kenntniss der Rotatoriengenera Lecane und Monostyla," *Zool. Anz.*, 1929, **83**, 143–64, 18 text-figs.). The author returns in this paper to the genera Lecane and Monostyla, to which he has given much attention for a number of years. In an earlier contribution to the same Journal (1924) he furnished careful descriptions, with excellent figures, of 9 species of these genera, including 1 species previously unknown and 8 others which had not up to that time been recorded for Germany. He now gives even more carefully drawn descriptions and figures of 19 species further to be added to the rotifer fauna of that country, 3 of which, viz., *Lecane rhenana*, *L. sympoda*, and *Monostyla perpusilla*, are introduced as new species. Of

the remaining 16 species, which have already become known elsewhere, 6 at least, viz., *Lecane subtilis, L. tryphema, L. elasma, Monostyla furcata, M. crenata* and *M. pyriformis*, do not appear to have been recorded as yet for the British Isles. There is no reason, one would think, why most of them, if not all, should not be met with in Britain, if searched for with equal keenness and insight. The same remarks apply to the species, exceedingly rare in Europe, which the author, following transatlantic specialists, has described as *Monostyla cornuta* (O. F. Müller), a name which seems to the present writer to be in reality the property of the relatively common species which Ehrenberg separated as *Monostyla lunaris*. The augmentation of the fauna of Germany by so many additional species of rotifers as are included in these two papers by Hauer is largely the result of the investigation of waters of soft or slightly acid character, and rotifer workers cannot be too strongly urged to neglect no opportunity of securing gatherings of such waters for examination, and especially from streams and pools wherein mosses are growing.

D. L. B.

The Rotiferan Genera Euchlanis and Monommata.—FRANK J. MYERS ("The Rotifer Fauna of Wisconsin. V. The Genera Euchlanis and Monommata," *Trans. Wis. Acad.*, Madison, 1930, 353–413, 17 pls.). In this fifth instalment of the great work started and hitherto carried on in collaboration with the late Harry K. Harring, of Washington, the author provides descriptions and figures for two somewhat distantly related groups of species belonging to the order Ploïma—on the one hand, the genus Euchlanis with its subgenera Dapidia, Dipleuchlanis and Tripeuchlanis, and on the other hand, a number of species of the genus Monommata (additional to two species already described in 1924 in the second instalment of the work). In accordance with the rule laid down for the earlier issues, all the species dealt with have been personally studied in the thorough and effective manner which we have learnt to identify with these authors. Would that anything approaching the same excellence could be justly attributed to some of their predecessors who have concerned themselves with the same genera. In all, the Euchlanidæ described number 16 species, of which 11 are assigned to the mother-genus Euchlanis, while 3 are placed in Gosse's genus Dapidia (now, however, reduced to the rank of a subgenus), and 1 other is sustained as a representative of de Beauchamp's subgenus Dipleuchlanis. These 15 species have their habitat in fresh water, but for one other species, which lives in salt water and has the illusory appearance of a three-tiered lorica, the new subgenus Tripleuchlanis is created. One may be permitted to express regret that it should have been thought desirable in these cases to use the designation "subgenus" and not the simple designation "genus" generally employed among rotifers. The former seems a rather unnecessary complication of a classification already sufficiently difficult to establish. It is gratifying to note that one of the new species of Euchlanis, *E. meneta*, common in several of the United States, is already known to be present in France, Germany, and England (? Scotland), and, further, that the author considers that Gosse's *E. oropha* is quite distinct from Rousselet's *E. parva*, a point which had been a matter of doubt. The most interesting thing about the Monommatæ is the great numerical increase in the known members of a genus so long represented by a single species, an increase partly due to the more searching study of their intimate structure, and partly to the geographical extension of that study. In this instalment are given figures and descriptions of 11 species of remarkably similar appearance, if not very closely scrutinized, two only of which have as yet been found in Europe, whilst the others have been detected first in the United States.

D. L. B.

Protozoa.

Methods for Collecting and Cultivating Infusoria.—L. H. Hyman ("Methods of Securing and Cultivating Protozoa. II. Paramecium and Other Ciliates," *Trans. Amer. Micr. Soc.*, 1931, **50**, 50–7). The author describes methods for collecting various ciliates (especially *Paramœcium, Stentor, Vorticella*) in their natural haunts, and for their subsequent maintenance in cultures, both mixed and pure. These methods are considered in detail, and useful instructions and references to the relevant literature are given. The original should be consulted for particulars. C. A. H.

A Spirotrichonympha from Termites.—E. E. Cupp ("*Spirotrichonympha polygyra* sp. nov. from *Neotermes simplicicornis* Banks," *Univ. Calif. Pub. Zool.*, 1930, **33**, 351–78, 4 pls., 16 figs.). A new xylophagous hypermastigote flagellate, *Spirotrichonympha polygyra* sp. n., was found in the gut of the termite *Kalotermes* (*Neotermes*) *simplicicornis*. It is characterized by four spiral flagellar bands arranged in dexiotropic coils. This number is reduced to two by division. The blepharoplast is situated at the extreme anterior end of the body, giving rise to the flagellar bands and the rhizoplast, which ends in a centrosome on the anterior surface of the nucleus. The flagella arise from the spiral bands, run posteriorly through the cytoplasm, then bend outwards and penetrate through the ectoplasm. The nucleus is surrounded by a thick fibrillar axostyle which protrudes from the posterior end of the body in the form of an arrow-head. A description of mitotic division is given. C. A. H.

Stages of Trypanosoma cruzi in the Malpighian Tubes of a Bug.—E. Dias ("Da presença de formas de evolução do *Trypanosoma cruzi* Chagas, nos tubos de Malpighi do barbeiro (Nota prévia)," *Mem. Inst. Oswaldo Cruz.*, 1930, **24**, 183–5, 3 pls.). The author examined sections and fixed smears of the digestive organs of *Triatoma megista*, the intermediate host of *Trypanosoma cruzi*. Apart from the stages found in the hind-gut by previous observers, masses of flagellates in the crithidial stage were discovered attached to the walls of the Malpighian tubes, where they apparently undergo multiplication. C. A. H.

Hypermastigote Flagellates from Termites.—V. E. Brown ("Hypermastigote Flagellates from the Termite *Reticulitermes*: *Torquenympha octoplus* gen. nov., sp. nov., and Two New Species of *Microjœnia*," *Univ. Calif. Pub. Zool.*, 1930, **36**, 67–80, 2 pls.). Three new forms of hypermastigote flagellates are described from American termites of the genus *Reticulitermes*. *Torquenympha octoplus* gen. n., sp. n., has an anterior nucleus; its neuromotor apparatus is composed of about sixteen anterior flagella, rhizoplast, centro-blepharoplast, central axostyle, and a parabasal ring of eight ovoid parabasal bodies. *Microjœnia* is regarded as a valid genus and not part of the life-cycle of *Spirotrichonympha*. The following two forms are described: *M. ratcliffei* sp. n. and *M. pyriformis* sp. n. C. A. H.

Behaviour of Leptomonas in Cultures.—M. Lwoff ("Un flagellé parasite hétérotrpohe: *Leptomonas oncopelti* Noguchi et Tilden (*Trypanosomidæ*)," *C. R. Soc. Biol.*, 1930, **105**, 835–7). It was previously established by the author that the indispensable constituents of a culture medium for the Trypanosomidæ were (1) polypeptides or peptones, and (2) a certain amount of blood. In the present study the cultural requirements of *Leptomonas oncopelti* were determined. It was found that this flagellate grew well without the slightest trace of blood in the medium. This was composed as follows: 2 p.c. solution of beef peptone

produced by pepsin digestion (rich in polypeptides) in 0·6 p.c. saline, at $pH = 7 \cdot 0$. Peptone resulting from a more advanced digestion of muscle by pancreatic juice can also be used. Abundant cultures could also be obtained in autolyzed yeasts. *L. oncopelti* thus does not require blood for its development. On the other hand, it is incapable of growing in solutions of incomplete proteins lacking certain aminoacids. This type of nutrition, when the organism requires polypeptides for its growth, and is incapable of synthetizing simpler compounds, is termed heterotrophic. C. A. H.

Cytoplasmic Inclusions in Euglena. — V. E. Brown ("Cytoplasmic Inclusions of *Euglena gracilis* Klebs," *Zeitsch. f. Zellforsch. u. Mikr. Anat.*, 1930, **11**, 244–54, 3 pls., 1 text-fig.). A description of the various cytoplasmic structures of chondriosomal nature in *Euglena gracilis*. These were brought out by fixation with the solutions of Kolachev and Champy, while acid fuchsin-thionin-aurantia and acid fuchsin-toluidin blue were used as stains. Bowen's modification of Champy-Kull's procedure was used to stain the plastidome. The following structures are recognized: the chondriome, represented by the small dark granules often occurring as double bodies; the pseudochondriome, which is a larger "chondriome-like" body staining lightly; the plastidome, equivalent to the group of bodies which form the plastids of plant cells. Chondriosomes and chromatophores multiply by division. The Golgi bodies of *E. gracilis* are spherical or discoidal with dark rims. Neither the reservoir nor the contractile vacuole are stained with osmic acid. C. A. H.

A New Flagellate from Termites.—F. H. Connell ("The Morphology and Life-Cycle of *Oxymonas dimorpha* sp. nov., from *Neotermes simplicicornis* (Banks)," *Univ. Calif. Pub. Zool.*, 1930, **36**, 51–66, 1 pl., 3 figs.). A new polymastigote flagellate, *Oxymonas dimorpha* sp. n., was found in the hind-gut of an American termite, *Neotermes simplicicornis*. This parasite differs from all other members of the genus in its great size (up to $195 \times 165\mu$) and in the structure of the neuromotor apparatus. The attached individuals become free during ecdysis, and give rise to smaller flagellated forms. The rostellum of these elongates and they become attached to the gut by a cup-shaped structure developing at its tip, while their motor organellæ degenerate. These structures are formed anew at each division of the nucleus. All stages of mitosis are described. C. A. H.

The Golgi Apparatus of Amœba.—V. E. Brown ("The Golgi Apparatus of *Amœba proteus* Pallas," *Biol. Bull.*, 1930, **59**, 240–6, 1 pl.). For the study of the Golgi apparatus, *Amœba proteus*, cultivated on wheat infusion with *Chilomonas* and *Zoochlorella* for food, was treated by the method devised by Nassonov and by Bowen's modification of Mann-Kopsch's method. The Golgi apparatus of this amœba appears in the form of globules with clear centres and dark rims and as small black granules. These bodies are blackened by osmic acid stained with thionin. They are believed to be homologous to the globules produced in metazoan gland cells during secretion. The contractile vacuole in *A. proteus* is formed by union of minute vacuoles in the endoplasm which are associated with the Golgi bodies. C. A. H.

A New Hæmoparasite from Californian Quail.—E. O'Roke ("The Morphology, Transmission and Life-History of *Hæmoproteus lophortyx* O'Roke, a Blood Parasite of the California Valley Quail," *Univ. Calif. Pub. Zool.*, 1930, **36**, 1–50, 2 pls., 6 figs.). Description of a new *Hæmoproteus*, *H. lophortyx* sp. n., from the California Valley Quail, *Lophortyx* sp. This species is compared with the well-

known *H. columbæ*, from which it differs chiefly in the dimensions of the different stages. Schizonts are found in the lungs, liver, and spleen of the bird; the merozoites occur in the endothelial cells of the capillaries of the lungs and in the epithelial cells of the liver; gametocytes alone are usually present in the peripheral blood. Transmission is effected by *Lynchia hirsuta* (Hippoboscidæ). The microgametes are fully formed inside the gametocyte, and escape through rupture of the cell-membrane. In the course of development of the macrogamete two polar cells are produced. During fertilization the entire microgamete enters the macrogamete. Gametogenesis, fertilization, and ookinete production were observed *in vitro* at room temperature. C. A. H.

Systematic Position of Castellani's Amœba.—M. Douglas ("Notes on the Classification of the Amœba found by Castellani in Cultures of Yeast-like Fungus," *Journ. Trop. Med. & Hyg.*, 1930, 2 pls.). The author describes the amœba found by Castellani growing in fungal cultures (see J. Roy. Micr. Soc., 1931, **51**, 51). This is a large form measuring 13·5 to 22·5μ in diameter, with one or more vacuoles. Typical pseudopodia are formed, and hair-like filiform ectoplasmatic processes are frequently present. The nucleus has a large round central karyosome. Chromatin may be present or absent outside the karyosome. Division is not described. The cysts, measuring 9–12μ in diameter, have a double contoured membrane, the outer surface being crinkled. The systematic position of the protozoon appears to be uncertain, but the author proposes the name *Hartmannella castellanii* sp. n. C. A. H.

Eocene of California.—J. A. Cushman and J. D. Barksdale ("Eocene Foraminifera from Martinez, California," *Cont. Dep. Geol., Stanford Univ.*, 1930, **1**, no. 2, 55–73, 2 pls., map in text). The material studied consisted of shales and grey siltstone, foraminifera being more plentiful and better preserved in the latter, though identical forms of the commoner species were obtained from both materials. Only 13 species and varieties were observed, all of which are well figured. They include two new species and two new varieties. A. E.

Miocene Foraminifera from Jamaica.—J. A. Cushman and P. W. Jarvis ("Miocene Foraminifera from Buff Bay, Jamaica," *Journ. Palæont.*, 1930, **4**, no. 4, 353–68, pls. 32–4). Previous knowledge of the foraminifera of the Miocene of Jamaica has been almost confined to the Bowden marl, which has a limited fauna, though some of the species are large and numerous. The Bowden marl was deposited in water of less than 100 fathoms. By contrast the foraminifera from Buff Bay represent a deeper habitat, between 100–200 fathoms, and the fauna is larger and more varied. Many of the species are still living in West Indian waters, while others are identical with species from the Miocene and Pliocene of Italy. There are also many species which have already been recorded from the Miocene of Trinidad and South America. One new species and one new variety described and figured. The plates are particularly good. A. E.

New Generic Name.—J. A. Cushman ("*Parrina*, a New Generic Name," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 102, 20). The generic name *Silvestria*, used by Schubert in 1920 for the organism originally figured and described by Brady (1884), in the Challenger Report, under the name *Nubecularia inflata*, had been preoccupied by Verhoeff in 1895 for a genus of the Diplopoda. The new name *Parrina* is proposed by Cushman for the foraminiferal genus as a substitute. A. E.

Dimorphism in Valvulina.—J. A. Cushman ("The Microspheric and Megalospheric Forms of *Valvulina oviedoiana* d'Orbigny," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 101, 17–8, figs. on pl. 3). D'Orbigny's species is one of the commonest shallow-water forms of the West Indian region, and is always represented by two very distinct forms, only one of which was originally figured. This is the microspheric form characterized by a low triangular test with few chambers rapidly increasing in size. The megalospheric form is narrower and much more elongate. There are minor points of difference also, the microspheric form having a pointed apex and an invariably triserial arrangement of the chambers, while the megalospheric form has a blunt apex and generally more than three chambers in the later convolutions. The aperture and character of the wall are similar in both forms. Similar dimorphism has been observed in the allied species *V. davidiana* Chapman from the Pacific, and will probably be found in the many related species known as fossils from Cretaceous strata upwards. A. E.

The Genus Flabellinella.—J. A. Cushman ("Some Notes on the Genus *Flabellinella* Schubert," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 100, 16–17, figs. on pl. III). The generic name was proposed by Schubert in 1900 for the separation of those species of *Frondicularia* in which the earliest chambers were arranged on a *Vaginulina* plan. Such specimens have usually been regarded as abnormalities, but Cushman, having examined a large number of specimens from the type locality, considers that the figures of the Cretaceous fossil *Frondicularia zitteliana*, published by Egger (1899), do not give an adequate idea of that species. In the microspheric form the chambers are oblique, with the aperture at the peripheral angle. Several chambers of this kind are formed before the adult *Frondicularia* plan is assumed. In the megalospheric form the *Vaginulina* stage is reduced or almost absent. On these grounds Cushman proposes the transfer of Egger's species to *Flabellinella*, which he regards as a valid genus with a range from the Jurassic to the Upper Cretaceous. A. E.

Miocene Foraminifera of San Joaquin Valley, California.—J. A. Cushman and F. L. Parker ("Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 99, 1–16, 3 pls.). Two samples taken from an Upper and Lower level respectively of the Temblor formation present some characteristic differences. The Upper sample is described as a *Valvulineria* silt, from the abundance of *V. miocenica* var. *depressa*, which also occurs in lesser numbers in the Lower sample, described as a *Siphogenerina* silt, from the enormous numbers of *S. transversa* which it contains. The fauna in general is very similar to that of similar deposits of Miocene age on the eastern side of North America, the West Indies, and northern South America. Many of the species are still found living on the Californian coast and in the Atlantic, having suffered little change since Miocene times. Other species died out with the Miocene, or survived only into the Pliocene of the same areas. Three new species and one new variety are described, and the paper is well illustrated. A. E.

BOTANY.

(*Under the direction of* A. B. Rendle, D.Sc., F.R.S.)

GENERAL.

Cytology.

Chemical Stimulus Essential for Growth.—F. S. Hammett ("The Chemical Stimulus Essential for Growth by Increase in Cell Number," *Protoplasma*, 1929, **7**, 297–322). The lead precipitate present in the meristematic region of root-tips grown in Pb – containing culture solutions is a combination of lead with sulfhydryl. Mitosis, but not growth by increase in cell-size, is inhibited in such tips. Sulfhydryl is concentrated in the meristematic region of normal roots. Acid extracts of the meristem of root-tips accelerated root-length growth when controlled by acid extracts of the next distal portion. Alkaline extracts similarly controlled showed no accelerating influence. Thus the root region of highest sulfhydryl concentration and mitotic activity contains a naturally occurring substance which stimulates root growth in length. The action of a variety of sulfhydryl compounds on mitosis in root-tips and reproduction rate in *Paramecium* was studied, using the same compounds minus the sulphur moiety as controls. The – SH group was found to stimulate cell division in both cases. Cell-size growth is not stimulated. It is concluded that sulfhydryl is the essential stimulus to growth by increase in cell number. J. L.

Tetraploid Roses.—E. W. Erlanson ("A Group of Tetraploid Roses in Central Oregon," *Bot. Gaz.*, 1931, **91**, 55–64). *Rosa Durandii*, *R. myriadenia* and *R. yainacercis* from Corvallis, Oregon, were examined cytologically and observed to be balanced tetraploids with 14 pairs of chromosomes at diakinesis. A semi-sterile *R. nutkana* was hexaploid. In certain characters these tetraploids resemble *R. nutkana*, in other characters they resemble the tetraploid *R. californica*. This tetraploid group has a limited geographical range from Central Oregon to Northern California. It may have originated from a cross between *R. nutkana* and *R. californica*. It is suspected that *R. delitescens*, *R. Brownii*, *R. calavera*, *R. pinetorum* and *R. muriculata* also belong to this tetraploid group. The cubes of the mean length of the pollen of diploid, tetraploid and hexaploid roses are as 1 : 1·7 : 1·9. It is suggested that pollen grain size might be used in distinguishing tetraploid and hexaploid rose forms in herbaria. J. L.

A Fertile Triple Hybrid of Nicotiana.—D. Kostoff ("A Fertile Triple Hybrid, *Nicotiana tabacum* × (*Nicotiana sylvestris* × *Nicotiana Rusbyi*): Preliminary report," *Amer. Journ. Bot.*, 1931, **18**, 112–13). Vigorous-growing triple hybrids were raised from the pollination of *Nicotiana tabacum* by *N. sylvestris* × *N. Rusbyi*. Amongst these triple hybrids intermediate types were found as well as those resembling more closely one of the parental plants. The intermediate types are fully fertile, the others partially so. The fertile triple hybrids have normal meiotic

divisions with 24 haploid and 48 diploid chromosomes. The partially fertile plants have irregular reduction division and usually $48 + 1$ or $48 + 2$ somatic chromosomes. An explanation on a cytological basis is given to account for the origin of the fully fertile triple hybrids. J. L.

Self- and Cross-incompatibility in Cabbage.—Y. Kakizaki ("Studies on the Genetics and Physiology of Self- and Cross-incompatibility in the Common Cabbage (*Brassica oleracea* L. var. *capitata* L.)," *Jap. Journ. Bot.*, 1930, **5**, 133–208). Certain mating between two different self-compatible plants is incompatible reciprocally, and between self-compatible plants and self-incompatible ones some matings are compatible only when the former are used as females, while others are compatible only when the latter are used as females. Self-compatible plants are obtained usually as descendants of self-incompatible ones, and self-compatible plants, when selfed, always segregate into both self-compatible and self-incompatible types. The results are explained by a new genetic hypothesis that two contradictory allelomorphic series, one oppositional S_1, S_2 and S_3, and the other sympathetic T_1 and T_2, affect the pollen-tube growth through the stylar tissue, and the S series is epistatic over the T series, but the T in double dose is more effective than the S in single dose. The slow rate of pollen-tube growth under incompatible pollination is due to the presence of a substance which inhibits growth in the stylar tissue. The S allelomorphs are responsible for the production of this inhibiting substance. Normal pollen-tube growth under compatible pollination is due either to the absence of an inhibiting substance or the presence of an accelerating substance, for the production of which the T allelomorphs are responsible. J. L.

An Aberrant Nicotiana.—James Kendall ("An Aberrant *Nicotiana* with 91 Chromosomes," *Amer. Journ. Bot.*, 1931, **18**, 114–15). A plant with 91 chromosomes in its somatic cells arose amongst the derivatives of the cross (*N. rustica* × *N. tabacum*) × *N. tabacum*. The morphological characters of the leaf and flower of this aberrant plant show the blending of certain of the features of the two species involved in its origin. Pollen development showed marked meiotic irregularities. In the first metaphase from 40–45 chromosomes could be counted, usually 44. Polyvalency apparently occurs. Lagging was also observed. As the result of irregularities in the second division, diads, triads, unequal tetrads, pentads and hexads were formed, with a high percentage of abortive pollen. The aberrant plant proved to be slightly self-fertile. J. L.

Chromosomes of Piper.—Donald A. Johansen ("The Chromosomes of *Piper subpeltatum*," *Amer. Journ. Bot.*, 1931, **18**, 134–5). The haploid chromosome number in *Piper subpeltatum* is 12, the diploid 24. The chromosomes are of extraordinarily small size. Previously 8 and 20 have been reported as haploid numbers for this species. It is suggested that a thorough cytological study of material from many localities is desirable. J. L.

Chromosome Numbers in Cucurbitaceæ.—J. W. McKay ("Chromosome Numbers in the Cucurbitaceæ," *Bot. Gaz.*, 1930, **89**, 416–17). A complete list is given of the reported chromosome numbers in the Cucurbitaceæ. J. L.

Chromosome Number and Morphology in Nicotiana.—John Milton Webber ("Chromosome Number and Morphology in *Nicotiana*. V. The Character of Tetraploid Areas in Chromosomal Chimeras of *N. sylvestris* Speg. & Comes," *Univ. Calif. Pub. Bot.*, 1930, **11**, 355–66). The somatic chromosome garniture of *Nicotiana sylvestris* consists of 24 chromosomes. With the exception of three

pairs, it is possible to analyze this somatic set on the basis of position of constrictions, and size distinctions. Thus there are at least six chromosomes with subterminal constrictions, two of which have satellites, four with approximately terminal constrictions, and eight with median constrictions. The remaining six lie curved in the centre of the plates in such a manner that their morphology is indistinguishable. A study of tetraploid cells and areas shows that the 4n cells do not multiply sufficiently to compete with normal diploid cell. This condition results in isolated 4n areas, from which, presumably, pure tetraploid roots, and possibly shoots, may arise. (Author's summary.) J. L.

Giant Pollen Grains of Hyacinthus.—ISAMU STOW ("Experimental Studies on the Formation of the Embryo sac-like Giant Pollen Grain in the Anther of *Hyacinthus orientalis*," *Cytologia*, 1930, **1**, 417–39). Embryo sac-like giant pollen grains are produced in the anthers of hyacinth bulbs which are subjected to high temperature during the reduction division stages of the pollen mother-cells, and then forced in a greenhouse. The usual type of giant pollen grain contains 8 nuclei, situated as in the embryo sac. More rarely abnormal types with 4 or 16 or more nuclei were seen. The formation of the sac-like giant pollen grains depends on the stage of pollen development, an abundance of dead pollen grains, and a suitable temperature. J. L.

Meiosis in Nolana Hybrids.—R. O. WHYTE ("Chromosome Studies. II. Interspecific Hybrids in the Genus *Nolana*," *New Phyt.*, 1929, **28**, 336–44). The hybrids examined were the four generations derived from the cross *Nolana prostrata* L. × *N. atriplicifolia* Hort. Lack of pairing is very evident in the F_1 plants, only three or four of the possible 12 bivalents being formed. The univalents are distributed fairly regularly to the opposite poles. From 5–10 p.c. good pollen is produced. In the F_2 plants diakinesis is normal, and from 10–12 bivalents are formed. About 50 p.c. good pollen is produced. In one F_3 plant a haploid flower with very irregular meiotic behaviour was found. It is probable that the plant bearing this flower was diploid, and that the haploid flower was an abnormality arising in the last growing season. The divisions in the other F_3 plants were normal. J. L.

Chromosome Behaviour in Alstrœmeria and Bomarea.—R. O. WHYTE ("Chromosome Studies. I. Relationship of the Genera *Alstrœmeria* and *Bomarea*," *New Phyt.*, 1929, **28**, 319–35). In meiosis, lateral pairing of threads is noted at two stages of development. The first, at the time of synizesis, is considered to be the expression of the homotype or somatic split. This becomes obscured in the later stages. The second lateral association is the heterotype pairing, the univalent members of a bivalent chromosome becoming arranged side by side. At interkinesis the spiral structure of the chromosomes may be observed. In *Alstrœmeria* 2n = 16, and the types of somatic chromosomes are as follows:—(*a*) large V, equal arms; (*b*) large V, unequal arms; (*c*) pair of chromosomes with proximal satellites; (*d*) three pairs of rods; (*e*) small V, unequal arms; (*f*) small V, equal arms. The bivalent chromosomes clearly show their relation to the somatic complement. The types observed are described and figured. The same somatic and meiotic types are found in the genus *Bomarea*. The increase in number (2n = 18) is due to an extra pair of type (*d*) somatic. Meiosis was also studied in interspecific hybrids of *Bomarea*, and irregularities such as non-conjunction and, rarely, non-disjunction observed. J. L.

Anatomy and Morphology

Evolution of the Vessel Segment.—F. H. Frost ("Specialization in the Secondary Xylem of Dicotyledons. III. Specialization of Lateral Wall of Vessel Segment," *Bot. Gaz.*, 1931, **91**, 88–96, 8 figs.). Scalariform intervascular pitting is a primitive condition in the organization of the vessel segment. Specialization of the scalariform pit produces transitional and opposite pitting. The rearrangement of opposite pits gives rise to the highly specialized alternate arrangement of intervascular pits. Pitting between vessels and parenchyma cells may be scalariform, transitional, opposite or alternate. The evolutionary development is the same as in the development of intervascular pitting. The pits may be fully bordered, half-bordered, or non-bordered. The fully bordered appears to be the most primitive, and gives rise during specialization to the half-bordered and the non-bordered types. The introduction of tertiary spirals in vessel segments of secondary wood is evidence of specialization. Spirals do not occur in the most primitive dicotyledonous woods. B. J. R.

Variation in Structure in Four North American Woods.—J. E. Myer ("The Structure and Strength of Four North American Woods, as influenced by Range, Habitat and Position in the Tree," *Bull. New York State Coll. For.*, 1930, **3**, 2B, 1–39). The species investigated were *Pinus Strobus, Tsuga canadensis, Acer saccharum* and *Quercus alba.* The texture and strength gave little evidence of being directly influenced by geographical range, but definite relationships appeared to hold between these factors and position within the tree. In the two coniferous woods the coarsest-textured wood was found at the 16-feet level, and the texture rapidly became finer towards the stump. Above the 16-feet level pine becomes finer-textured, while hemlock shows little fluctuation. The ray volume of these two species was greatest at the top of the merchantable bole and at stump height. Position in the tree does not appreciably affect the strength of pine wood (maximum crushing strength parallel to the grain); the strength values for hemlock are constant for the first 16 feet and then decrease towards the top. In sugar maple there is no general relationship between geographical range, texture and strength; position in the tree, on the other hand, has an appreciable influence on texture and strength. Strength increases slightly from the butt to the 16-feet level, above which it remains fairly constant. In white oak, wood from the North-Eastern United States was found to have the smallest spring-wood vessels. Texture becomes coarser from the centre outwards, but does not vary with distance above ground level. The strength reaches a maximum at the 16-feet level, and decreases above and below this point. B. J. R.

Abnormal Wood Structure in Tsuga Mertensiana.—R. Kienholz ("The Wood Structure of a 'Pistol-butted' Mountain Hemlock," *Amer. Journ. Bot.*, 1930, **17**, 739–64, 11 figs.). Trees growing on hillsides frequently become bent over while young, due to the weight of snow or to insecure rooting. Their natural response to gravity causes them to grow erect again and even to bend back past the vertical. This produces a shape which is called "pistol-butted." This paper deals with the structure of the wood of a "pistol-butted" mountain hemlock (*Tsuga Mertensiana*) in comparison with a normal, erect-growing tree of the same species. The inclination of the stem is associated with an eccentric structure, the width of the annual rings in early life being greatest on the downhill side at the $1\frac{1}{2}$-feet and $6\frac{1}{2}$-feet levels. The proportion of the annual ring occupied by summer wood at the $1\frac{1}{2}$-feet level is greatest on the downhill side; at the $6\frac{1}{2}$-feet level it is

greater along the uphill than the downhill radius. Compression wood is well developed near the pith along the downhill radius at the $1\frac{1}{2}$-feet level, there being practically none on the uphill or sidehill radii. This is reversed at the $6\frac{1}{2}$-feet level, where there is more compression wood along the uphill than along the downhill radius. The dimensions of the tracheids at the $1\frac{1}{2}$-feet level are least along the downhill radius. In all cases the dimensions of the tracheids increase from the centre of the tree outwards and from the base of the tree upwards. B. J. R.

The Root Nodules of Hippophaë rhamnoides, Alnus glutinosus, and Cycads.—L. Borm ("Die Wurzelknollchen von *Hippophaë rhamnoides* und *Alnus glutinosus*," *Bot. Archiv.*, **31**, 3 & 4, 441–88, 23 figs., English abstract). This is an account of an extensive investigation of the root nodules of *Hippophaë rhamnoides*, *Alnus glutinosus*, and certain Cycads belonging to the genera *Dioon*, *Bowenia*, *Ceratozamia*, and *Cycas*. The anatomical structure of the nodules of each of the plants is dealt with in turn. The endophytes of *Hippophaë rhamnoides* and *Alnus glutinosus* were also isolated from the plants and their behaviour studied in agar cultures. The chief points brought out in the investigation are as follows :—The endophytes of the root nodules infect quite distinct regions of the gall, of which the cells become much enlarged. "The ~~nodules~~ become amœboid, and the endophytes multiply until they fill the cell completely, thus obscuring the nucleus." The bacteria now become decomposed by a phagic process. The phagic processes were also observed in cultures of the endophytes, especially when the medium was unsuitable. It was found possible to prove that the endophytes of *Alnus* are capable of fixing nitrogen. C. R. M.

Breathing Roots of Mangroves.—Wilhelm Troll ("Über die sogenannten Atemwurzeln der Mangroven," *Ber. der Deutsch. Bot. Gesch.*, 1930, *Generalversammlungs Heft* 81–99, 12 figs., 3 pls.). This is an account of the development of the breathing roots of *Sonneratia* spp. and the "knees" which occur on the roots of *Brugiera*. The observations on these plants were made during an expedition to the Malay Archipelago in conjunction with Dr. Otto Dragendorf, chemist to the expedition. In the author's opinion there is no justification for the view that the breathing roots, which project upwards above the substratum, are of primary importance for purposes of respiration. He regards them rather as adaptations to the nature of the medium in which the plants grow. In a young plant of *Sonneratia* the root system consists of horizontal string-roots from which vertical outgrowths are given off, extending above the substratum. Absorbing roots are given off below the substratum. In the mangrove swamps in which these plants grow, there is a constant admixture of fresh and salt water as the tide rises and falls, which results in a precipitation of any sediment that may be present, so that the level of the substratum is gradually raised. It thus happens that the primary absorbing roots become deeply embedded in the substratum. When this occurs, fresh roots are developed on those parts of the root system which had hitherto been above soil-level. These roots are of two kinds, described as feeding and anchoring roots respectively. Fresh string-roots which run horizontally are also formed, from which fresh vertical branches are put out and extend above the substratum. The author regards this mode of growth as being necessary for a plant which inhabits a substratum of which the level is constantly rising. In *Brugiera* the main roots grow horizontally, but rise above the surface of the substratum, and, having formed an arch, proceed to develop beneath the substratum again. These arches or "knees" have hitherto been regarded as "breathing" organs on account of their unusual structure. However, it is in association with the "knees" that

fresh absorbing roots are developed, whilst those that were previously formed become decomposed as the level of the substratum is raised. It thus happens that, by virtue of the manner in which the " knees " arise, the active roots are developed near the surface of the constantly rising substratum in which the plant is growing.
C. R. M.

The Aerenchyma of Sesbania and Neptunia.—C. R. METCALFE (" The Aerenchyma of *Sesbania* and *Neptunia*," *Kew Bull. Misc. Inform.*, 1931, 151–4, 5 figs.). An account of the structure and development of the " aerenchyma " on the submerged stems of *Sesbania* sp. and *Neptunia oleracea.* In both plants the aerenchyma is a secondary tissue formed by the activity of a phellogen. In *Sesbania* sp. the phellogen is situated in the cortex not far outside the endodermis, as previously noted by Scott and Wager, and Schenck. In *Neptunia oleracea*, on the other hand, the phellogen arises not far below the epidermis. C. R. M.

The Stem Epidermis of Certain Sugar-Cane Varieties.—E. ARTSCHWAGER (" A Comparative Study of the Stem Epidermis of Certain Sugar-Cane Varieties," *Journ. Agric. Res.*, **41**, 12, 853–65, 9 figs., 1 pl.). An account of a study of the epidermis of certain varieties of *Saccharum officinarum* carried out in order to discover any characters of diagnostic value. Preparations of the epidermis were made by treating portions of stem with potassium chlorate and strong nitric acid, and subsequently staining them with chloroiodide of zinc. The epidermis is made up of cells of two types, designated " long " and " short " respectively. The " short " cells are usually in pairs, of which one member is a cork cell and the other a silica cell. Sometimes the silica cell is absent, or, on the other hand, there may be more than two short cells in a group. It is chiefly on the variations in size of the cells, and the number and arrangement of the " short " cells, that varieties can be distinguished from one another. Stomata are not numerous in any of the varieties examined, but their presence may be used as a diagnostic character in certain instances. A key has been constructed by means of which it is claimed that a certain number of varieties may be identified. C. R. M.

The Structure of the Starch Layer on the Glossy Petal of Ranunculus.—J. PARKER (" The Structure of the Starch Layer on the Glossy Petal of *Ranunculus*," *Ann. Bot.*, **45**, 177, 201–5, 9 figs.). In a transverse section of a petal of one of the common English species of *Ranunculus* the starch layer appears to be about three cells thick, and situated immediately beneath the upper epidermis. However, when longitudinal sections are taken, it can be seen that the starch layer consists in reality of a single layer of cells arranged obliquely. The development of the starch layer has been followed in *R. Ficaria.* It is of interest that in *R. Ficaria* the slope of the starch cells is directed downwards and inwards towards the base of the petal, whereas in *R. acris, R. bulbosus*, and *R. repens* the slope is upwards towards the apex of the petal and inwards. It is thought that this fact indicates that *R. acris, R. bulbosus*, and *R. repens* are more closely related to one another than to *R. Ficaria.* It is suggested that the structure of the starch layer may be of value in working out a phylogenetic scheme of the genus. C. R. M.

Histology of the Almond.—V. A. PEASE (" Notes on the Histology of the Almond," *Journ. Agric. Res.*, 1930, **41**, 11, 789–800, 4 figs.). An account is given of the histology of four varieties of soft-shelled almonds from the United States of America and four hard-shelled varieties imported from Europe. The chief differences are found to occur in the outer epidermis of the testa. In the soft-shelled varieties slightly lignified cells are present, which are regarded as poorly

developed stone cells, whereas the corresponding cells of the hard-shelled varieties are more elongated and strongly lignified than in those with soft shells. It is hoped that these facts may be utilized as a basis on which to distinguish different varieties of almond in the shelled condition, and thus avoid misrepresentation or adulteration.

C. R. M.

The Effect of Spiral Ringing on Solute Translocation and the Structure of the Regenerated Tissues of the Apple.—L. H. MACDANIELS and O. F. CURTIS ("The Effect of Spiral Ringing on Solute Translocation and the Structure of the Regenerated Tissues of the Apple," *Cornell Univ. Agric. Exptl. Stat. Memoir* 133, 1930, 11 figs., 5 pls.). An account of experiments in which young apple trees were ringed by removing strips of tissue extending twice round the trunks in a spiral manner, and observations were made on the resulting effect on translocation as revealed by nitrogen analysis of the leaves, and catalase determinations. The structure of the regenerated tissues was also examined. In some instances only the bark and phloem were removed, but in others the outer ring of xylem was removed as well. These experiments show that the food substances are normally translocated in directions parallel to the axes, and that lateral translocation is slow. Lateral transfusion may, however, be increased by spiral ringing. It was found that, if nitrate was added to the soil, nitrogen movement to the branches immediately above the end of the spiral was reduced. Later on, however, these effects disappeared, this fact being correlated with the production of the elements in the regenerated tissues in such a way that their long axes were arranged parallel with the spiral. After ringing, opportunity for lateral conduction in the regenerated tissues was afforded first by the connection of the vessels through their radial walls, but later on, owing to the orientation of the cambium so as to be parallel to the spiral ring, a path for translocation was made possible through the end walls. It is concluded that most translocation occurs in the phloem, since the removal of this tissue alone had almost as great an effect on translocation as removal of the outer xylem as well. It is thought that cambial growth results from the coming together of food from the leaves and nutrients from the roots.

C. R. M.

The Path of Translocation of Food Materials in the Plant.—W. SCHUMACHER ("Untersuchungen über die Lokalisation der Stoffwanderung in den Leitbundeln höherer Pflanzen," *Jarhb. für Wiss. Bot.*, **73**, 5, 770–823, 12 figs.). The author gives an account of a very extensive and careful investigation carried out in order to determine once and for all the path by which nitrogen is translocated in the plant. A comprehensive review of previous work on the subject is given. A great deal of the present work was carried out on the petioles of *Pelargonium zonale*. A transverse section of such a petiole reveals the presence in it of a peripheral ring of vascular bundles and one large central bundle. It was found possible, by surgical methods, to remove the outer tissues of the petiole in such a way that the parent leaf was connected to the mother plant only by means of the central bundle. It was even possible to isolate the phloem and xylem in the central bundle, thus enabling direct observations to be made on the influence on translocation of the severing of different parts of the vascular bundle. Experiments were also carried out with various colouring solutions on a wide range of plants in order to determine the paths of translocation. As a result of these investigations, the author claims to have proved conclusively that the sole paths by which nitrogen is translocated over long distances is through the sieve tubes of the phloem.

C. R. M.

Unrolling of Leaves of Musa sapientum.—A. F. Skutch ("Unrolling of Leaves of *Musa sapientum* and Some Related Plants, and their Reactions to Environmental Aridity," *Bot. Gaz.*, **90**, 4, 337–65, 23 figs.). This is a study of the mechanism by which the leaves of certain members of the Scitamineæ become unrolled. The genera chosen for study were *Musa* and *Heliconia* from amongst the Musaceæ, *Alpinia* from the Zingiberaceæ, *Canna* from the Cannaceæ, and *Calathea* from the Marantaceæ. The genera under consideration are characterized by the possession of a false stem, within which the laminæ of the leaves are almost fully developed before they emerge. The vernation is convolute. The unrolling is effected by the enlargement of the cells of the upper water tissue, which takes place in such a way that the veins, which hitherto have been retained within the lamina, so that the latter is smooth at the surface, become raised above the general level of the lamina, thus giving rise to the ribbed appearance characteristic of the mature leaves. In *Musa* the fibres on the ventral side do not become thickened until the lamina has expanded, whereas those on the dorsal side are thickened before the leaves unroll. The expansion cells become enlarged from the margin of the leaf inwards and from the apex downwards. Experiments were carried out in which the leaves were bound up so that they were unable to expand in the normal way. When this is done, in most instances the expansion cells undergo an excessive enlargement. Conversely, in *Musa* if the leaves are unrolled prematurely and held open, the expansion cells do not become enlarged. In *Musa*, *Heliconia* and *Calathea* the lamina are bent outwards from the midrib, owing to the expansion of cells along the midrib, whilst in *Alpinia* cells at the centre of the midrib carry out a similar function. In *Musa* a tissue of prismatic cells is developed along either side of the midrib. By the action of these cells, combined with that of the upper expansion tissue due to changes in turgor, the two halves of the lamina become folded together downwards in dry weather, the stomata, which are situated chiefly on the lower surface, being thus brought together. In other members of the Scitamineæ, however, when there is excessive drought, water is lost from the expansion cells and the infolding is partly reversed. In consequence, in these leaves the stomata on the lower surface become more fully exposed under dry conditions, so that the movement is non-adaptive in character. C. R. M.

The Places of Exit on the Surface of Pollen Grains.—P. M. L. Tammes ("On the Origin of Number and Arrangement of the Places of Exit on the Surface of Pollen Grains," *Recueil des trav. bot. Néerlandais*, **27**, 1–84, 3 pls., 21 figs.). This extensive paper is divided into three chapters, in which the following subjects are considered:—(1) The morphology of the normal pollen; (2) variations in pollen morphology; (3) the causes of the variability and arrangement. A statistical study of pollen has been made, from which it is concluded that there is a definite correlation between the size of the grain and the number of "places of exit" (germ-pores). When the germ-pores are in one plane, the following relation appears to be true:—$D = a$ to $a + 1 \times V$ where D represents the diameter of the grain, a the number of germ-pores observed, and V a constant for pollen grains of any one species under standard conditions. When, on the other hand, the pores are distributed over the surface of the grain, the relation is $D = (\sqrt{a \text{ to } a + 1} \times V$. In cases of polyploidy it has been established that there is a correlation between chromosome number and size of pollen grain. At the same time it is possible for the number of germ-pores to vary according to the size of the pollen grain even when there is no variation in chromosome number. In whatever way the arrangement of the germ-pores may vary, as a general rule

the distance between the individual pores is constant. From these facts it is concluded that the number of pores on a pollen grain is the highest possible on the surface available for their formation. C. R. M.

The Trap of Utricularia capensis.—F. E. Lloyd ("The Structure of the Trap of *Utricularia capensis*," *Journ. Bot. Soc., S. Africa*, **16**, 5–10, 5 figs.). An account of the structure and mechanism of the traps of *Utricularia capensis*. A full account is also given of the traps of *U. gibba*, and a comparison is made between the two species. The traps of *U. capensis* are said to agree closely with those of *U. Welwitschii*. C. R. M.

Anatomy of the Composite Flower.—M. F. Koch ("Studies in the Anatomy and Morphology of the Composite Flower. II. The Corollas of the Heliantheæ and Mutiseæ," *Amer. Journ. Bot.*, **17**, 10, 995–1010, 5 figs., 2 pls.). This is the second of a series of articles dealing with the morphology and anatomy of the Composite flower. In the Heliantheæ the author considers that the vascular strands in the ray corolla are derived partly from bundles belonging to the corolla itself, but in addition three large veins are present appressed to the under side. These are regarded as the median veins of three reduced sepals which have become fused with the corolla. A series of figures is given showing the phylogenetic series of events which may have given rise to this condition. It is maintained that the median bundles of the primitive composite corolla have become lost, as have also the lateral veins of the sepals. Furthermore, two of the sepals are thought to have disappeared completely, thus leaving the median veins of three calyx leaves which have become fused with the corolla. *Bidens cernua* is regarded as a typical member of the Heliantheæ in which these appressed bundles are present. In the ray floret of *Rudbeckia triloba* vestiges of stamens are present, in *Helenium autumnale* no appressed bundles are present, and the morphology of *Grindelia squarrosa* was found to be characteristic of the Heliantheæ. In the Mutiseæ there are three kinds of florets—ray, tubular, and bilabiate. The venation of the ray corolla is similar to the "Aster" type, and that of the tubular resembles the "Discoid" type. The base of the bilabiate floret is similar to that of the disc floret, but in the tube of the corolla "the members of three fused lateral bundles separate at the three sinuses to supply a strap-shaped lobe and two shorter lips." The author does not consider that the bilabiate corolla of the Mutiseæ represents an intermediate stage in the derivation of the ray corolla, but rather regards the corollas of the Mutiseæ as variations of the disc corolla. Anatomical details did not reveal any close affinities between the Compositæ and any family usually regarded as being closely related. C. R. M.

Studies in the Morphology of the Cruciferous Flower.—A. Arber ("Studies on Floral Morphology. I. On Some Structural Features of the Cruciferous Flower," *New Phyt.*, **30**, 1, 11–41, 10 figs.). The author states that she has returned to the study of the floral anatomy of the Dicotyledons, more especially with a view to understanding the andrœcium. She is also convinced that the volume of theory which has been built up on the subject of the gynœcium is too great to be supported by the known facts of floral structure. The author also points out that much of the existing work dates from pre-microtome days. As a preliminary to overcoming these defects, a study of the organization of the normal flower of certain Cruciferæ has been attempted, the results of which are here described. Detailed descriptions of the floral anatomy of the following species are given:—*Sisymbrium Alliaria* Scop., *Sisymbrium orientale* L., *Raphanus sativus* L., *Raphanus maritimus* Sm., *Crambe maritima* L., *Nasturtium officinale* R. Br., *Lunaria rediviva* L., and

L. annua L. An important point shown by many Cruciferous plants is an absence of radial symmetry in the pedicel, e.g., in *Lunaria rediviva* L. and *Nasturtium officinale* R. Br. This fact is thought to indicate that there is no rigid distinction between stem and leaf structures. Multicellular but non-vascular structures described as squamules were associated with the young pedicels and leaves of several Cruciferous flowers. They recall the "squamulæ intravaginales" of the Helobieæ. The author regards them as possibly representing "the stipules of the axillant leaf (bract), which is absent except for these vestigial appendages." Eichler's floral diagram of the Cruciferous flower, which has often been reproduced in text-books, indicates that the median sepals are the outer pair. This, however, is not correct, since serial sections show that the lateral sepals are invariably the first to be given off. This is well seen in *Nasturtium officinale*. The early origin of the midrib bundles of the outer sepals is also clearly seen in certain species, e.g., *Sisymbrium Alliaria*. A very remarkable fact is that the lateral strands of the sepals in many of the Cruciferous flowers examined do not arise from the median bundles of the sepals at all, but are entirely petaline in origin. This was also noted by Klein. It is thus clear that, unless the absurd suggestion that the margins of the sepals are petaloid in origin is adopted, it must be concluded that the vascular bundles "are perfectly capable of disregarding morphological boundaries." Several different arrangements of glands at the base of the stamens are described. These glands are provided with fine vascular strands which are not lignified, but more closely resemble the elements of protophloem. The vascular strands arise in a different manner in the different plants examined. They arise sometimes from the "bundles of lateral sepals, the bundles of the petals, the bundles of the outer stamens, and the margins of the gaps left on the vascular cylinder by the outer stamen bundles." The author favours the view that the glands are receptacular outgrowths. Likewise the view is held that the inner stamens consist of a whorl of four members, as opposed to Eichler's contention that the inner stamens constitute a dimerous whorl of which each member has become two by "dédoublement." This is supported by the fact that the bundles of the stamens of each so-called "pair" arise quite independently, and not by the splitting of a single member. In studying the gynœcium, observations have been made on the origin of the placental strands, and the important point "that both the valve and replum vascular systems contribute to the formation of the placental strands" has been definitely established in a number of plants. The modern revival of the old view that the Crucifer gynœcium consists of four carpels is, in the author's opinion, unlikely, since the valve and replum bundles belong to two different carpels, two of which are "fertile" and two "sterile." It is pointed out that the quadricarpellary theory is based on anatomical evidence which does not stand examination, and its adoption involves greater complications than does the bicarpellary theory. To sum up the discussion of this subject, the author states that "to ask how many carpels are involved in such a gynœcium is a purely scholastic question which can never receive an answer because no answer exists." C. R. M.

The Morphology of the Onagraceæ.—D. A. Johansen ("Studies on the Morphology of the Onagraceæ. III. *Taraxia ovata* (Nutt.) Small," *Ann. Bot.*, **45**, 177, 111–24, 1 pl., 4 figs.). A study of the fertilization and embryology of *Taraxia ovata* (Nutt.) Small, a plant which is becoming extinct from the endemic flora of California, chiefly since it is unable to reproduce by seed. The author considers that the plant is normally propagated by "the formation of offshoots which grow slightly above and away from the parent root, and eventually become completely detached." The elongated apex of the ovary, which for 86 years has been regarded

as a "calyx" tube, is now looked upon as an adaptation by means of which the flowers are carried above the leaves. Fertilization and early stages in the development of the embryo proceed normally. However, the later stages are abnormal, and the embryo, having become differentiated into two cotyledons, a short hypocotyl and a radicle, undergoes no further development. Apogamous embryos are sometimes found, but since no mitosis was observed, their chromosomal constitution was not ascertained. It is conjectured, however, that they are haploid. In addition to ovarian sterility, three different types of ovular sterility also exist, which depend on the failure of the nucellus to develop normally. It is thought that perfect individuals fail to arise owing to a lack of co-ordination amongst the various groups of cells which make up the embryo during its development. C. R. M.

Schizocotyly in Acer.—J. LATTER ("Schizocotyly and Genetic Variation in Acer," *New Phyt.*, **30**, 1, 66–8, 1 fig., 1 pl.). Brief reference is made to previous records of abnormal seedlings in the genus *Acer* in which the number of cotyledons that developed was higher than two. A description is then given of abnormality observed in a large number of seedlings from a garden at Godalming. Abnormality was shown in seedlings having three cotyledons or cotyledons which were bifurcated. In the tricotyledonous seedlings the abnormality extended to the foliage leaves. One tricotyledonous seedling produced a pair of opposite foliage leaves, one of which was bipartite with two normal-sized lamina borne on the common petiole. Another seedling, kept under observation until it was 20 inches high, had three cotyledons, and in each season's growth produced whorls of three leaves on the main axis. Lateral branches developed from the main axis in whorls of three during the last year's season. Each lateral branch was of normal type, with opposite leaves. The anatomy of the main axis was abnormal only in having a larger number of bundles in the vascular cylinder. The emission of the leaf and bud traces was normal. It is pointed out that these and previously recorded abnormalities were associated with drought and high lime content of the soil. C. R. M.

Abnormal Flowers of Mustard.—L. P. KHANNA ("Abnormal Flowers of Mustard (*Brassica alba*)," *New Phyt.*, **30**, 173–5, 5 figs.). A description of some abnormal flowers of *Brassia alba* brought in for class purposes by students at University College, Rangoon. In some instances the number of stamens was reduced to four or five, and there was a corresponding increase in the petals. In some instances the petals carried anthers. Abnormal gynœcia were also found, on which the pistil was differentiated into a stalk and an expanded leaf-like portion on which naked ovules were borne. On a branch arising from the junction of the stem and leaf-like portion a number of normal flowers were formed. The structure of the stalk resembled that of a pistil, the blade-like portion was ovate with inwardly rolled margins, and the apex was stigma-like with elongated cells projecting from the surface. Ovules were present on a pad-like structure formed by the projection of the midrib above the surface of the lamina throughout its length. Ovules were also present at the junction of the lamina, stalk, and branch, and on the rolled margins of the lamina. The ovules were normal in structure, but long-stalked. C. R. M.

Teratological Studies in Antirrhinum majus L.—B. BARNES ("Teratological Studies. I. Receptacular Outgrowths in *Antirrhinum majus* L.," *New Phyt.*, **30**, 1, 56–65, 6 figs.). A description of three abnormal flowers, labelled A, B, and C, respectively, from two plants of *Antirrhinum majus*. Flower A was found on a self-sown plant growing on a small rockery on a calcareous soil during a drought in 1929. The flower was remarkable for having a single calyx of five

sepals and two corollas. One of the corollas was normal except for the presence in it of a hollow, instead of a ridge, in front of the tube near the base. The second corolla lay partly in this hollow and partly in front of it. The abnormal corolla, which was very small in size compared with the normal one, was found to arise from an outgrowth of the receptacle. It consisted of an upper and a lower lip, in which the upper one resembled the upper lip of the normal flower in colour, but on its inner surface was a turf of white hairs like that found on the lower lip of the normal flower. The lower lip, which was hollowed internally, agreed with the normal lower lip in colour. No sexual organs were associated with the abnormal corolla. Flower B was found on a plant growing near A, but later in the season, when the drought was nearly over. It was remarkable in that the posterior part of the left antero-lateral sepal was green and sepaloid, whereas its front portion had a petaloid extension forming a bluntly pointed hood. The structure arose from a lateral outgrowth from the receptacle. In flower C the left antero-lateral sepal strongly resembled that of B, but the hooding of the petaloid ridge was less pronounced and the colour less intense. The sepal was weakly attached to the receptacle. There was present in the middle line on the inner side of the sepal at its base " a pale yellow kidney-shaped body with the convexity towards the centre of the flower." The author considers that the petaloid margin of the sepal was not merely an extension of the sepal, but consisted of petaline material applied to the inner surface of the sepal. The right antero-lateral sepal was normal as seen from the outside, but bore at its base " a small pad of parenchymatous material " consisting of a yellow basal and red distal portion. Sections showed that pigments were present in the epidermal cells of this structure, while a few chlorophyll granules were present in the internal cells. In section the red portion was found to consist of a number of tightly packed lobes not arranged in any recognizable order. The remaining sepals of flowers B and C were normal. In discussing his results the author concludes that " the unusual conditions all seem to be attributable, in the first place, to the production of an outgrowth from the receptacle between calyx and corolla, but not necessarily in the axils of the sepals." C. R. M.

Abnormalities in the Ovaries of Helianthus decapetalus Linn. var. multiflorus Bailey.—C. J. Berkeley (" Abnormalities in the Ovaries of *Helianthus decapetalus* Linn. var. *multiflorus* Bailey," *New Phyt.*, **30**, 1, 42–55, 38 figs.). The normal ovary of the Compositæ consists of two median anterior-posterior carpels which unite at their edges. The single erect anatropous ovule arises from the floor of the chamber. The mass of the ovule is made up of the single integument. Previous records of variations from this normal arrangement are mentioned, after which a description is given of abnormal ovaries in *Helianthus decapetalus* var. *multiflorus* discovered by the author. Although the inflorescences used were examined for abnormalities other than those in the ovaries, none were found. Those inflorescences, in which a preliminary rough examination revealed the presence of abnormal ovaries, were later cut in half and each floret examined individually. Each floret was given a Roman and Arabic figure representing an arc of the florets and the sequence of the florets in the arc respectively, so that a record was kept of the position of each floret in the capitulum. All the ovaries from the capitula known to contain abnormal ones were fixed, cleared, and examined by transmitted light. Sections were then cut of any ovaries in which the presence of more than one ovule was thus revealed. In some ovaries there was a thin filament arising from near the point of attachment of the ovule. Filaments of this kind, which correspond to the " cordulæ " described by Brown, sometimes bear small apical swellings, swellings covered with yellow hairs, or a single pendent

ovule. The single pendent ovule in one ovary bore two lobes, and in one other two basal and one pendent ovules were observed. The vascular structure of abnormal ovaries examined by means of serial sections is fully described. The most important point is that by a combination of bundles at the centre of the ovary a ring of vascular tissue is formed which subsequently divides into three. The middle one of these three groups supplies the normal ovule, whereas the other two, which are frequently much reduced, supply the " cordulæ." All the abnormal ovules found were attached to the sides of the loculus, and their vascular supply was derived from the " cordulæ." There is a long discussion in which suggestions are made concerning the origin of the upright position of the ovule in the Compositæ. An attempt is also made to account for abnormal ovaries, which are usually situated near the centres of the capitula. The suggestion is put forward that their formation is connected with the quantities of food available at different stages in the development of the capitula. C. R. M.

Variation in the Flowers of Lychnis dioica Linn.—W. M. Curtis ("Variation in the Flowers of *Lychnis dioica* Linn.," *New Phyt.*, **30**, 1, 69–72, 2 figs.). An account of variations in the colour and form of the petals, and variations in the calyx, of flowers of *Lychnis dioica* collected from two localities in a hedgerow at Hambledon, Surrey. The variations were found, not only in different plants, but in the individual flowers on any one plant as well. C. R. M.

CRYPTOGAMS.

Pteridophyta.

Osmunda Meristem.—George L. Cross (" Meristem in *Osmunda cinnamomea*," *Bot. Gaz.*, 1931, **91**, 65–76, 15 figs.). The rhizome of *Osmunda cinnamomea*, when in the sporeling stage, grows by means of a tetrahedral apical cell. As maturity is approached, the segmentation of the apical cell becomes less and less regular, and finally the apical cell is lost, and is replaced by two or more initials. Cells destined to become desmogen tissue may be recognized in the second segment from the apical cell. Owing to the slow growth of the rhizome and the frequency of leaf gaps, it is almost or quite impossible to refer any portion of the mature rhizome to any definite portion of the segments of the apical cell or of the initials. The pericycle and endodermis appear to have independent origins. The roots arise in the tissue which later gives rise to the pericycle. The undifferentiated endodermis serves as a protecting layer to the young root. Most young roots have an apical cell with five cutting faces, but in maturity this becomes replaced by two or more initial cells. The evidence gained by the author supports Bower's conclusions that the Osmundaceæ are intermediate between the leptosporangiate and the eusporangiate ferns. A. G.

Campylogramme.—K. Goebel (" Pteridologische Notizen. 1. Campylogramme Trollii n. sp.," *Flora*, 1931, N.F. **25**, 281–8, 4 figs.). Description of a new fern, *Campylogramme Trollii*, collected by Dr. W. Troll on the island of Pulu Berhala, near Sumatra, in dense forest, in 1929, and under cultivation in Munich Botanic Garden. The affinity of the plant is discussed, and seems to approximate to *Antrophyum*. A. G.

Pleurosoriopsis gen. nov.—A. Fomin (" Ueber die *Anogramma Makinoi* H. Christ," *Bull. Jard. Bot. Kieff*, 1930, **11**, 8–9). The author is convinced that *Anogramma Makinoi* cannot be left in *Anogramma*, differing as it does from that genus in having reniform, not tetrahedric, spores, as well as a creeping branched

rhizome and an abundance of articulated hairs. He therefore creates for it a new genus, *Pleurosoriopsis*, allied to *Hecistopteris* J. Sm., and gives a description of the genus and species. A. G.

Bracken Spores.—J. H. WHYTE ("The Spread of Bracken by Spores," *Trans. Proc. Bot. Soc., Edinburgh*, 1930, **30**, 209–11). Bracken is generally supposed to spread mainly by vegetative means. The author produces evidence that the spread of bracken by spores is neither impossible nor rare. Burned-out sites tend to be free from fungal hyphæ, and in such places, if moist, the bracken spores have the best chance of germination. A. G.

Dominica Ferns.—KAREL DOMIN ("The Pteridophyta of the Island of Dominica, with Notes on Various Ferns from Tropical America," *Mem. Roy. Czech Soc. Sci. Nat. Hist. & Math, Praha*, 1929, N.S. no. 2, 1–259, 40 pls.). A monograph of the ferns of Dominica, with introductory remarks, climatological notes, botanical explorers of the island, botanical literature on Dominica, and a systematic enumeration of the pteridophytes. These are comprised in 51 genera. The species are numerous, and several of them are described as new. A. G.

Chinese Ferns.—C. R. CHING ("The Studies of Chinese Ferns, I.," *Sinensia, Nanking, China*, 1930, **1**, 43–56, 7 pls.). A contribution towards a proposed monograph of Chinese ferns. Here are descriptions of 10 new species belonging to 7 genera. *Meniscium simplex* Hook. is shown to be but a simpler form of *M. triphyllum* Sw., as is proved by the gradation of forms figured in the 7 plates; the modern name of the species is *Dryopteris triphylla* C. Chr. *Gymnopteris cantoniensis* Baker is more fully described, and is transferred to the genus *Campium*. A. G.

Marquesas Island Selaginellæ.—OTTO CHR. SCHMIDT ("Neue Arten der Gattung *Selaginella* von den Marquesas-Inseln," *Fedde's Repertorium*, 1930, **28**, 236–8). In a small collection from the Marquesas Islands received from F. B. H. Brown, of the Bishop Museum, Hawaii, were *Selaginella arbuscula* Spring, *S. laxa* Spring, *S. vitiensis* Baker, as well as three new species—*S. Browneana*, *S. Bishopiana*, *S. Jonesii*, which are described by the author. A. G.

Bryophyta.

Water-supply of Polytrichum.—ESTHER J. BOWEN ("Water Conduction in *Polytrichum commune*," *Ann. Bot.*, 1931, **45**, 175–200, 1 pl., 7 figs.). Contrary to preconceived ideas, the main water-supply of *Polytrichum commune* passes up over the external surface of the plant in the form of capillary films between the closely adherent leaf-bases and the stem; this process is facilitated by the densely arranged leaves and the tufted habit of the plant. The form and structure of the leaf-bases are described, as also their mode of attachment to the stem. The effect of heat and damp on the angle of divergence of the leaves from the stem is determined. The rate of conduction of the upward external current is determined by a number of methods, and the amount of the water current is calculated. The penetration of the water into the stem takes place through the leaf-bases and leaf-traces, especially at the apex of the plant, and a lateral and downward passage of the liquid in the stem is demonstrated. Attempts were made to determine the extent of the conducting capacity of the central strand; the function of this latter appears to be to support and strengthen the stem rather than to conduct water. A. G.

Schwetschkea and Glossadelphus.—R. POTIER DE LA VARDE ("Sur deux mousses indiennes," *Ann. Crypt. Exot.*, 1930, **3**, 101–5). Among the mosses collected by Père Foreau in Southern India is a species of *Schwetschkea* with obscurely papillate leaves and with paraphysoid hairs at the base of the calyptra; and the author argues that it is probably identical with *S. indica* Broth. It is conceivable, too, that *S. gracillima* Fleischer may prove to be the same species, but, until the type is available for examination, no decision can be reached. Among Foreau's mosses are specimens of *Glossadelphus anisopterus* Broth. with mature capsules and with autoicous inflorescence. The latter character shows that the plant is not a variant of *G. Zollingeri* Fleisch., and the opportunity is seized for giving a precise description of the capsule, peristome and operculum. A. G.

Haplocladium.—I. THÉRIOT ("Le genre *Haplocladium* en Asie et en Afrique. Essai de Revision," *Ann. Crypt. Exot., Paris*, 1930, **3**, 57–100, figs. 1–17). The author explains how the genus *Haplocladium* was created without proper description by C. Müller; how Brotherus supplied a description, but subsequently transferred the genus to the subfamily Anomodontoideæ, where it is out of place. So it is now restored to the Euthuidioidæ, being of near affinity to *Thuidium* and especially *Rauia*. It is redefined, mainly in terms of its ramification, leaf characters (form, size, plication, papillæ, costa), perichætium, seta and capsule. A chronological list of Asiatic and African species is given, and these, apart from four doubtful species, become reduced to 12 Asiatic and 2 African species, with some varieties. Two of the species are new to science. A. G.

Meesea.—WILLIAM CAMPBELL STEERE ("*Meesea triquetra*," *Rhodora*, 1931, **33**, 77–8, 1 pl.). In a small post-glacial pond 12 miles north of Ann Arbor, Michigan, was found a fine fruiting tuft of the uncommon moss *Meesea triquetra*. This is a circum-boreal species, characterized by its three-ranked squarrose leaves with serrate margins, and by the pear-shaped capsule on a very long seta. The habit is well rendered in the photo-plate. A. G.

Fossombronia.—G. CHALAUD ("Sur la place en systématique de *Fossombronia Fleischeri* Osterw.," *Verhandl. Bot. Verein Prov. Brandenburg*, 1930, 69–74, 6 figs.). Reasons are given for separating off from *Fossombronia* the species *F. incurva* and transferring it to the allied genus *Simodon*, as Lindberg did in 1889. Its most important characters are the terminal perianth and axillary antheridia. In 1928 an unpublished species, *Fossombronia Fleischeri* Osterw., from the environs of Berlin, was described, and its systematic position was discussed by L. Loeske. In the present paper the characters of *Simodon incurvus*, *F. Fleischeri* and *F. Crozalsii* are carefully contrasted, and *F. Fleischeri* is accepted as a sound species of *Fossombronia*. A. G.

Bryophyta of Savoy.—P. CULMAN ("Contribution à la flore bryologique du bassin supérieur de l'Arve," *Bull. Soc. Bot. de France*, 1930, **77**, 463–73). As a contribution towards the supplement, which the author hopes to produce, to the various catalogues of Muscineæ published by Venance Payot, the present list of 43 hepatics and 146 mosses represents the most interesting of the species which the author has collected in the upper valley of the Arve, near and above Servoz. Critical notes and notes on the localities explored are added. A. G.

Azores Bryophytes.—ELEONORA ARMITAGE ("Some Bryophytes of the Azores," *Journ. Bot.*, 1931, **69**, 75–6). A list of 16 mosses and 13 hepatics collected in São Miguel, Azores, during a very brief visit in March, 1930. The mosses were

named by H. N. Dixon, the hepatics by W. E. Nicholson. Three of the mosses are additions to the flora recorded for the Azores. A. G.

Indian Mosses.—H. N. Dixon and R. Potier de la Varde ("Nouvelle contribution à la flore bryologique de l'Inde," *Ann. Crypt. Exot., Paris*, 1930, **3**, 168–93, 6 figs.). A systematic account of the mosses collected on the Sirumalai, Pulney and Kannam Deva Hills by Foreau; on the Western Ghats and High Wavy Mountains by Blatter and Hallberg; and in the environs of Bombay by McCann. A score of new species are described, one representing a new genus of Entodontaceæ—*Nanothecium*—and an enumeration of 65 species, interesting for their rarity or their distribution, is given. A. G.

Chinese Hepaticæ.—William E. Nicholson, Theodor Herzog, and Frans Verdoorn ("*Symbolæ Sinicæ*. V. Teil: *Hepaticæ*," *Herausgegeben von Heinrich Handel-Mazzetti, Wien*, 1930, 1–60, 21 figs.). An account of the hepaticæ collected by the expedition of the Akademie der Wissenschaft in Wien to south-west China, 1914 to 1918. It comprises 201 species belonging to 73 genera, and 43 of the species are new to science, while *Macvicaria* is a new genus of Lophoziaceæ, which much resembles *Fossombronia* in habit; its capsule is 16-valved, and the elaters monospirous. *Cephaloziella hunanensis* is the smallest of its genus, and its leaf cells (4–6μ) are probably the smallest known in the hepaticæ. These Chinese hepatics are closely allied to the Himalayan, and they contain some peculiar instances of discontinuity of distribution, for certain species which were known only from Atlantic Europe and the Himalaya have been found to occur in China. A. G.

Thallophyta.

Algæ.

Siberian Phytoplankton.—B. W. Skvortzow ("Phytoplankton from Siberia," *Journ. of Bot.*, 1931, **69**, 33–8; 69–72, 3 figs.). The first part of this paper is a list of algæ collected in the Akmolinsk Lake district by P. T. Ignatow, 30 years ago. It contains 80 species and varieties of Flagellatæ, Cyanophyceæ, Diatomaceæ and Chlorophyceæ, including two new varieties of *Trachelomonas*. The second part gives a tabulated list of 68 species and varieties from the Altai Mountains, collected by A. N. Sedelnikov in 1914 and 1916. The third part contains a similar tabulated list of 50 species, varieties, etc., collected by W. K. Soldatow from the Amur River, near Habarovsk, in 1910 to 1914. No plankton from the Amur had been recorded previously. A. G.

Diatomaceæ.—N. Ingram Hendey ("Notes on the Diatomaceæ," *Pharmaceutical Journ.*, 1931, **126**, 127–30, 4 figs.). A brief survey of the Diatomaceæ—their history, habitat and geological age, morphology, physiology, locomotion, reproduction, and their economic value and applications. The diatoms now constitute a class by themselves—the Bacillariophyta. The first evidence of their abundance is found in the Miocene strata, and diatom deposits exceeding 1,000 feet in thickness are found in California. Attempts to prove their presence in coal have failed. At the present time the number of diatom species recognized is about 10,000. In size they vary from 5μ to 500μ in diameter, the majority being from 50μ to 100μ. The ultimate structure of the minute markings on the valve has yet to be revealed. The diatoms do not form starch, but a highly refractive oil, which has been suspected to be the source of the vast deposits of petroleum. Genera belonging to the section Pennatæ have the power of slow movement in a straight

line, but the mechanism of the movement is still unknown. The economic uses are many. The deposit is mined, and the crude diatomite is used for lining furnaces, etc., as an insulator. The powder is used as an abrasive in a number of preparations, or as a filtering material. Diatomite serves as a catalyst carrier in the manufacture of soap. It is a useful absorbent in other chemical processes, such as the purification of acetylene, and the minute structure of the organism has been responsible for the development of apochromatic objectives. A. G.

Spring Diatom Increase.—S. M. MARSHALL and A. P. ORR ("A Study of the Spring Diatom Increase in Loch Striven," *Journ. Marine Biol. Assoc.*, 1930, **16**, 853–78, 15 figs.). The spring diatom increase in the sea is an important biological event. It takes place more rapidly inshore than in the open sea. Loch Striven is a well-sheltered loch in the Clyde sea area. The authors give the detailed results of their study (at intervals of two days) of the spring increase for three consecutive years, at which time the diatom flora consisted almost entirely of *Skeletonema costatum*. Contemporaneous experiments with diatom cultures and sea-water samples helped to elucidate the changes which occurred. Vertical mixing of the water layers was found to have an important effect on the form of the increase. It was also found that, though there is a relationship between organic matter oxidizable by permanganate and the total number of diatoms present, there is no relationship between *dissolved* organic matter oxidizable by permanganate and diatoms. A. G.

Mass-developments of Diatoms.—H. BETHGE ("Einige Fälle von Massenentwicklung bei Diatomen," *Ber. Deutsch. Bot. Ges.*, 1931, **48**, 490–503, 3 figs.). The author describes two sudden unexpected mass-developments of diatoms in Germany. One was at Dresden in December, 1929, when in some great cement basins on the banks of the Elbe an immense development of diatoms occurred, giving the water a bad smell and depositing a thick slime, the principal constituent of which was *Melosira varians* Ag. The second case occurred in the Gross Storkower See in November and December, 1929, when *Melosira Binderana* Kutz. was so abundant that net fishing became impossible. A detailed examination of this water and of its sediment was made, and lists of the species are given. The plankton flora of the Havel at Potsdam, in December, was investigated. A mass-development of *Melosira islandica* O. Müller in Hjälmar See in Sweden is mentioned. A. G.

Saline Diatoms.—HERMANN BUDDE ("Die mesohaloben und halophilen Diatomeen der Lippe in Westfalen," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 415–19). A list of 34 brackish or marine diatoms resulting from an investigation of the waters of the River Lippe from Hamm to its mouth, with notes on the associations observed. A. G.

Kamtchatka Diatoms.—STELLAN ERLANDSSON ("Marine Diatoms collected by the Swedish Kamtchatka-Expedition, 1920–1922," *Arkiv. för Botanik*, 1931, **23A**, no. 8, 1–10, 3 figs.). A list of the diatoms, 46 species and varieties, collected at Akhomten Bay, on the east coast of Kamtchatka, by the Swedish Expedition in 1920. An *Ectocarpus*-like tuft proved to be a large growth of the stalked diatom *Schizonema Grevillei* Ag., and most of the other diatoms were found living epiphytically upon it. A. G.

Diatoms of the Permian and Carboniferous Formations.—D. VITO ZANON, S.O. ("Diatomee del Permiano e del Carbonifero," *Mem. della Pont. Accad. delle Scienze—I Nuovi Lincei*, serie II, 1930, **14**, 89–124.) In 1874 Count

Castracane announced his discovery in English and French coal of salt and fresh-water diatoms, similar in all respects to recent forms. Investigations similar to those of Castracane were undertaken by Deby and Tempère, but these were entirely unsuccessful, and Castracane's claims were generally discredited. Dr. Zanon, who says he himself was sceptical with regard to the correctness of Castracane's views, has been working for three or four years on the same subject, and his methods and conclusions are described in this publication. His work was carried on in the official chemical laboratory of the Custom House at Rome, in collaboration with Dr. Riccardo Tuffi, the chief chemist, and in accordance with the advice and suggestions of Prof. Michele Gortani of Bologna University. Adequate precautions appear to have been taken to prevent any possible admixture of other diatomaceous material. Dr. Zanon claims that he found abundant and incontrovertible proof of the existence of diatoms in Permian and Carboniferous deposits, and he gives a list of some 60 species belonging to the following genera of diatoms :—Achnanthidium, Amphora, Cœconeis, Cymbella, Cyclotella, Epithemia, Eunotia, Fragilaria, Gomphonema, Hantzschia, Melosira, Meridion, Navicula, Nitzschia Odontidium, Pinnularia, Rhopalodia and Synedra. These species, illustrated in a series of drawings by the author, are mainly identical with present-day forms, but a few are extinct fossil forms. J. A. L.

Geochrysis turfosa.—A. Pascher (" Eine braune, aërophile Gallertalge und ihre Einrichtungen für die Verbreitung durch den Wind," *Beihefte zum Botan. Centralbl.*, 1931, **47**, 325–45, 2 pls., 12 figs.). Description of a new genus and species of alga, *Geochrysis turfosa*, belonging to the Chrysocapsales section of Chrysophyceæ. It forms an expanded olive-brown gelatinous layer, often profuse, on peat or mossy ground. The gelatinous layer is composed of a multitude of roundish cells, which contain a brown chromatophore and a contractile vacuole, form a gelatinous wall (laminated or not), and divide actively. The cells have the power of changing into uniciliate swarm-cells resembling *Chromulina*. The form of the cell and the shape of the swarm-cell prove the alga to belong to the Chrysocapsales. The interest of the new alga lies in the fact that it has adapted itself for distribution by wind. The gelatinous layer when desiccated breaks up into a powder composed of single cells or groups, all protected by a strong gelatinous coat. Scattered by the wind, they swell up and germinate if they fall upon wet places, and either form swarm-cells or undergo active vegetative multiplication. A. G.

Lithophytic Cyanophyceæ.—Anton Ercegović (" Sur quelques types peu connus des Cyanophycées lithophytes," *Archiv. für Protistenk.*, 1930, **71**, 360–76, 6 figs.). The author finds that under *Pleurocapsa* there are two species—*P. fuliginosa* and *P. minor*—which differ, not only in genus, but also in family ; and having studied the type specimens, and having investigated material on the Adriatic coast, he is able to describe and establish the generic differences between *Pleurocapsa* and *Scopulonema*, a new genus. In the former he includes two species—*P. fuliginosa* and *P. crepidinum* (transferred from *Gleocapsa*). The type of *Scopulonema* is *S. Hansgirgianum*, which morphologically resembles *Pleurocapsa minor* (Hansg.) Geitl. He also describes some new species of *Solentia* and *Hormathonema*, and discusses these two lithophytic genera. He gives an analytical key to six genera of Chamæsiphoneæ—*Pleurocapsa, Dalmatella, Hyella, Solentia, Hormathonema, Scopulonema.* A. G.

Myxophyceæ of Madagascar.—Abbé Pierre Frémy (" Les myxophycées de Madagascar," *Ann. de Crypt. Exot., Paris*, 1930, **3**, 200–30, 8 pls.). A complete list of the blue-green algæ recorded from Madagascar, mostly collected by Henri

Humbert and by H. Perrier de la Bathie, and comprises a systematic list of 90 species, 24 of which are new for Madagascar, 2 for Equatorial Africa, and 8 for Africa as a whole. A. G.

Burmese Myxophyceæ.—S. L. Ghose ("Five More Myxophyceæ from Burma," *Journ. Ind. Bot. Soc.*, 1931, **10**, 35–7, 1 pl.). Descriptions of five blue-green algæ not previously recorded from Burma, including *Scytonema leptobasis*, a new species; and there is a new variety of *Tolypothrix limbata*. A. G.

Crystals in Closterium.—O. Kopetzky-Rechtperg ("Über die Kristalle in den Zellen der Gattung *Closterium* Nitzsch (Desmidiaceæ)," *Beihefte zum Botan. Centralbl.*, 1931, **47**, 291–324, 2 pls.). A detailed investigation of the crystals in cells of *Closterium*. The number of crystals in the terminal vacuoles is dependent on the place of occurrence of the plant as well as on other factors (age, etc.), but is not a characteristic of the species. In some species the form and general development of the crystals are a constant character. The crystals consist, in all probability, of calcium sulphate, but conclusive proof of this has not yet been obtained. Nor is there any convincing proof of their function. They might be regarded as metabolic excreta of the desmid cell, which are deposited similarly in the terminal vacuoles of the two halves of the cell. A. G.

Botrydium.—Marie Rosenberg ("Die geschlechtliche Fortpflanzung von *Botrydium granulatum* Grev.," *Österr. Bot. Zeitschr.*, 1930, **79**, 289–96, 1 pl., 4 figs.). An account of the stages in the developmental history of *Botrydium granulatum*, with the structure of the swarm-spores, and the fusion of the gametes in pairs or triads. The zygote may undergo a period of rest before germinating and growing into the normal pyriform coenocyte. Sometimes the gametes escape fusion and develop parthenogenetically. A. G.

Acetabularia.—Bruno Schussnig ("Phykologische Beiträge III. *Acetabularia Wettsteinii*, n. sp., im Mittelmeer," *Österr. Bot. Zeitschr.*, 1930, **79**, 333–9, 4 figs.). Description of the characters of *Acetabularia Wettsteinii*, a new species found at the Sirenen-Inseln (I Galli), in the Gulf of Salerno, in the summer of 1928. It is a smaller plant than *A. mediterranea*, from which it differs in various details. The gametes are described. A. G.

Heterogamy in Enteromorpha.—Harald Kylin ("Über Heterogamie bei *Enteromorpha intestinalis*," *Ber. deutsch. Bot. Ges.*, 1931, **48**, 458–64, 14 figs.). The publications of Schussnig, Hartmann and Föyn upon the alternation of generations in *Cladophora Chætomorpha*, *Ulva* and *Enteromorpha* led the present author to study three of these genera at Kristineberg biological station in the summer of 1930, and a brief description of the developmental history of *Enteromorpha intestinalis* is given. The alternation of generations is confirmed, and whereas in *E. compressa* and *E. ramulosa* isogametes are formed, in *E. intestinalis* there is heterogamy. The spore-bearing fronds and zoospores are described; also it is shown how the female differ from the male gametes, and an account of copulation, the zygotes, and germination, is given. A. G.

Protoplasmic Connections.—Faustino Miranda ("Las comunicaciones interprotoplásmicas en *Bornetia secundiflora* (J. Ag.) Thuret," *Bol. Real Soc. Española Hist. Nat.*, 1930, **30**, 201–4, 2 figs.). The Florideæ afford good material for the study of intercellular protoplasmic connections. Mangenot (in *Revue Algologique*, 1924, p. 376) extended to them the name of "plasmodesmes," which Strasburger had used for phanerogams in 1901. In *Bornetia secundiflora* they attain

very large dimensions in the spermatangial branchlets, reaching a width of 52μ. The protoplasms of the two neighbouring cells are not in direct contact, but are bounded each by a thin membrane which stains strongly with iron hæmatoxylin; and each of these membranes adheres closely to a striated disc which constitutes the middle layer guarding the pore. The disc as seen in transverse section is split at each end, and this fact may have given rise to the view that the pore is bounded by a double ring. It may be that the structural details of the pore vary with the position and function of the cells. A. G.

Ahnfeltia.—L. Kolderup Rosenvinge ("The Reproduction of *Ahnfeltia plicata*," *Kgl. Dansk. Vidensk. Selsk. Biol. Meddel.*, 1931, **10**, 2, 1–29, 18 figs.). The reproduction of *Ahnfeltia* is peculiar. Antheridia, carpogonia, cystocarps and tetrasporangia are wanting. Only nemathecia are known, different from other nemathecia in that in *Ahnfeltia* they produce terminal monosporangia, while other algæ produce seriate tetrasporangia in the nemathecial filaments. But the filaments which produce monosporangia are not primary nemathecial filaments. These latter arise in the autumn from superficial cells of the frond, and in their cell-rows they early produce two special kinds of cell—(1) flask-shaped cells, terminal, carpogonial in shape and staining deeply in their walls; possibly they are reduced, functionless organs; (2) generative cells formed at the top of the primary nemathecial filaments, and rich in protoplasm; from them arise secondary nemathecial filaments, but these must be regarded as a new generation comparable to the sporophytic generation (*Actinococcus*) of *Phyllophora Brodiaei*. The significance of these and of the monosporangia is discussed. In a postscript reference is made to B. D. Gregory's recent paper on *Actinococcus* and *Sterrocolax*, and to E. Chemin's paper on *Ahnfeltia plicata*. A. G.

Fertilization in Hesperophycus.—Ruth I. Walker ("Fertilization and Embryo-Development in *Hesperophycus Harveyanus*," *La Cellule, Lierre*, 1931, **40**, 173–92, 3 pls., 2 figs.). The author gives a *résumé* of previous investigations of the reproduction of Fucaceæ, and gives the results of a study of *Hesperophycus Harveyanus* from California. The plant is monœcious, bearing antherids and oogones in the same conceptacle. An oogone normally produces two cells of unequal size, the uninucleate egg and a smaller 7-nucleate cell; both these cells escape from the oogone. Terminal cells of branching hyphæ form pear-shaped antherozoids, which escape at maturity. The egg membrane is penetrated by an antherozoid in 15 minutes. The antherozoid nucleus travels to and fuses with the egg nucleus. The fusion nucleus contains two nucleoli. The nuclear changes, chromosomes, spindles, etc., are described. The first nuclear division is transverse; a second transverse division divides the embryo; thus we have an apical, a central, and a rhizoidal cell. Longitudinal divisions occur in the two former cells, and a transverse division in the rhizoid initial. In a 4-day-old embryo periclinal divisions are visible in the apical region, and anticlinal in the central region; transverse and oblique divisions occur in the rhizoid region, and some of the daughter cells develop into rhizoidal hairs. The development of atypical eggs (immature oogones) is described. A. G.

Antheridium of Chara.—James Groves ("On the Antheridium of *Chara zeylanica* Willd.," *Journ. Bot.*, 1931, **69**, 97–8, 1 fig.). Ordinarily in Characeæ the wall of the antheridium is octoscutate, being composed of eight more or less triangular shields, but the author finds that in *Chara zeylanica* the antheridial wall is exceptional in being composed of four lozenge-shaped shields—a figure of which is

given—the same structure being found in all representatives of the species examined from Africa, Asia, and America. But in allied species the structure is octoscutate.
A. G.

Swedish Characeæ.—O. J. Hasslow ("Sveriges Characeer," *Bot. Notiser*, 1931, 63–136). An account of the Characeæ of Sweden, with descriptions, keys, and distribution, comprising 11 species of *Nitella*, 3 of *Tolypella*, and 16 of *Chara*.
A. G.

French Algæ.—P. Allorge and M. Lefèvre ("Algues de Sologne," *Bull. Soc. Bot., France* [1931], Session extraord. 1925, **72**, 122–50, 132 figs.). An enumeration of the freshwater algæ collected in 1925–26 in Sologne, a district of lakes and bogs to the south of Orleans. The list comprises 327 species and numerous varieties, including 51 Flagellatæ, 12 Peridineæ, 35 Diatomeæ, 5 Heterokonteæ, 34 Euchlorophyceæ, 187 Conjugatæ, and 3 Rhodophyceæ. Descriptions are given of 5 new species and 5 new varieties.
A. G.

Spanish Algæ.—Pedro Gonzáles Guerrero ("Algas del rio Zujar (Badajoz)," *Bol. Real Soc. Española Hist. Nat.*, 1930, **30**, 223–7, 10 figs.). A list of 25 Cyanophyceæ collected in the River Zujar, Esparragosa de Lares (Badajoz), in November, 1926, at a depth of half a metre. Two new varieties, of *Glœotrichia natans* and *Nodularia spumigena*, are described and figured.
A. G.

Dalmatian Algæ.—Achille Forti ("Il Contributo di Maria Selebam de Cattani agli Studi delle Alghe Marine e di certe sue Raccolte conservate a Venezia (Studi de Nomenclatura)," *Nuovo Giorn. Bot. Ital.*, 1930, **37**, 747–55). A list of 85 marine algæ collected at Zara and at Pago by Maria Selebam de' Cattani (1789–1870), together with an account of her life, her pursuits, and her scientific correspondents. The herbarium names of the algæ are set out in the first column, and the corresponding modern names in the second.
A. G.

Bulgarian Algæ.—St. Petkoff ("Note supplémentaire à la flore algologique d'eau douce sur les côtes bulgares de la Mer Noire," *Bull. Soc. Bot. de Bulgarie*, 1931, **4**, 103–13, 1 pl.). A supplementary note on freshwater algæ collected by B. Stephanoff beside the Kargan and the Véléka, in south-east Bulgaria, near the shore of the Black Sea. It comprises 47 species with 9 varieties and 7 forms. Descriptions and figures of some new forms of *Œdogonium* are given. Appended is a list of 13 species of freshwater algæ gathered by N. Stojanoff in eastern Thrace.
A. G.

Indian Algæ.—F. Boergesen ("I.—Some Indian Rhodophyceæ, especially from the Shores of the Presidency of Bombay," *Kew Bull.*, 1931, 1–24, 2 pls., 15 figs.). An account of some new or interesting red algæ collected in the winter 1927–28, mostly at Dwarka and Okha Port, near the entrance to the Gulf of Cutch, and some from Carwar, in the south of the Bombay Presidency. Included are some Karachi algæ collected 50 and 70 years ago and now preserved in the Kew Gardens herbarium. The list contains 21 species, 5 of which are new to science, comprising 2 species of *Scinaia*, 1 of *Monospora*, and 2 of *Myriogramma*. Critical notes are added to the other species. Several species from the north end of the Arabian Sea are found to be the same as, or very closely allied to, species from Australia, but they appear to be wanting in the hot seas which separate the two districts.
A. G.

Indiana Algæ.—C. Mervin Palmer ("Algæ of Marion County, Indiana. A Description of Thirty-two Forms," *Butler Univ. Bot. Studies*, 1931, **2**, paper no. 1,

1–21, 32 figs.). An illustrated list of the algæ collected by the author and his pupils in the neighbourhood of Butler University, Indiana, including 11 Myxophyceæ. 1 red alga, 1 desmid, and 19 Chlorophyceæ. A. G.

Brazilian Algæ.—Marshall Avery Howe and William Randolph Taylor ("Notes on New or Little-known Marine Algæ from Brazil," *Brittonia*, 1931, **1**, 7–33, 2 pls., 16 figs.). An account of the algæ collected by Prof. L. Agassiz, Count Pourtalès amd Dr. Thomas Hill, of the Hassler Expedition, by dredging off the coast of Brazil in 1872. The specimens are preserved in Harvard University herbarium. An earlier collection of Brazilian algæ was made by St. Hilaire and was determined by R. K. Greville in 1833. Greville's types have been borrowed from Edinburgh and examined by the present authors, and some of them are figured here. The number of species is 13, and 8 of them are described as new. Critical notes are added. A. G.

Argentine Algæ.—Hans Seckt ("Algenforschung in Argentinien, II," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 420–7). An alphabetical list of all papers which have any bearing on the algæ of Argentina. A. G.

Fungi.

Study of Phytophthora.—E. M. Blackwell and G. M. Waterhouse ("Spores and Spore Germination in the Genus *Phytophthora*," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 294–310, 7 text-figs.). The authors have studied, by means of cultures, etc., the different forms of spore production in *Phytophthora*—the various conidia, sporangia, chlamydospores, oospores (by fertilization and as a parthenogenetic body). They give an account of these bodies already described, the conditions of germination—the condition of the medium, the temperature, and of the spore itself. They have concluded that no precise distinction exists between sporangia, conidia, chlamydospores and sphæroconidia—the latter only abnormal hyphal swellings in old cultures; sporangia that do not produce zoospores become transformed to conidia. Conidia ripen to resting conidia, and in some species are represented by chlamydospores. They stress the importance of maturation, on which is dependent the method of spore-germination. Under normal conditions the method and time of germination depend mainly on the maturity of the spore. A. L. S.

Aquatic Fungi.—John Ramsbottom (*Journ. Quekett Micros. Club*, 1931, **16**, 151–67, 1 pl.). Under this title the author has given an outline of the subject-matter of the filamentous fungi that live on water plants or animals. The best known, the Saprolegniaceæ, were first noted in 1743; later came the discovery that these fungi parasitized many kinds of fish. Other fungi live on dead plant material, and a Pyrenomycete has recently been discovered on stones in streams, and has been described as a *Hydronectria*. The paper closes with a discussion on the relation of fungi to the lower ranks of green algæ. The Chytridiaceæ are also reviewed: they mostly live on land plants, sometimes in the roots of marsh plants, but many of them parasitize filamentous green algæ and desmids. These Chytridiaceæ have often been described as Protozoa. The paper was given as a presidential address to the members of the Quekett Microscopical Club. A. L. S.

Sclerospora on Cereals.—L. E. Melchers ("Downy Mildew on Sorghum and Maize in Egypt," *Phytopathology*, 1931, **21**, 239–40). This fungus, *Sclerospora graminicola* var. *Andropogonis Sorghi*, was found both on *Sorghum* (durra) and on maize—the oogonia and oospores were present in the plant tissues, similar to those

described as occurring in India. It was while cultivating plants for experimental purposes that the fungus was discovered, all the plantings being infected. So far it has only been found at Giza. The source of infection is not known, but it is suggested that the fungus may have been introduced on packing materials from India. A. L. S.

Conidia of Phytophthora.—G. M. WATERHOUSE ("The Production of Conidia in the Genus *Phytophthora*," *tom. cit.*, 311–21). The author has studied this question in three species from temperate climes and three tropical. Cultures were made on potato agar, etc., and in water; observation was made on the effects of the particular medium, solid agar or water, on the importance of air supply and of temperature. The effect of light was also tested, but results varied. The effect of water was most marked, an excess more than doubling the production of conidia, and the solid media also reacting to the moisture content by an increase in the number of conidia. A. L. S.

Mucorineæ from India.—S. L. AJREKAR and K. DHARMARAJULU ("A Study of the Mucorineæ of the City of Bombay," *Journ. Ind. Bot. Soc.*, 1931, **10**, 29–34, 1 pl.). The authors obtained material for study by incubating dungs from various animals. As the fungi appeared they were isolated and their development watched on suitable culture media. They secured 8 different mucors belonging to 5 genera. One species was new to science. In *Mucor racemosus* they induced the formation of zygospores and proved the heterothallic nature of the mould. A. L. S.

A New Penicillium.—H. KLEBAHN ("*Penicillium Ehrlichii*, ein bemerkenswerter neuer Schimmelpilz," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 374–89, 14 text-figs.). The new fungus appeared on cultures in a beet-sugar factory. It presented several unusual features, but was finally referred to *Penicillium* n. sp. The conidial form consists generally of almost solitary branches bearing strings of conidia. The perithecial form occurs frequently; asci and spores are abundant. Klebahn gives a discussion on the probable systematic position; finally he has concluded that it may belong to the group *anomala* as an abnormal species. A. L. S.

Study of Ascobolaceæ.—ETHEL GREEN ("Observations on Certain Ascobolaceæ," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 321–32, 7 text-figs.). The writer found that spores of the species tested germinated at a temperature of 22° C. without preliminary treatment and without a resting period. The influence of artificial conditions of growth on development and cytology was observed. As the natural habitat—dung—is subject to change, an artificial medium was substituted and was used with success. The spores and mycelia are mostly heterothallic, but certain monosporic cultures have also produced apothecia, though only after considerable delay. Archicarps are small and soon become entangled; their cells are at first uninucleate, but become multinucleate; several enter into an apothecium. A. L. S.

Sclerotinia sclerotiorum.—RALPH E. SMITH ("The Life-History of *Sclerotinia sclerotiorum*, with Reference to the Green Rot of Apricots," *Phytopathology*, 1931, **21**, 407–23, 6 text-figs.). An investigation was undertaken to specify the exact nature of green rot. It was evidently due to a *Sclerotinia*, but *Botrytis cinerea* was constantly present, and was presumed to be also a causal agent. Cultures were made and evidence collected from all possible sources. The attack by the fungus varied in different years. Thus in 1929 and 1930 no case of

green rot occurred, nor were any apothecia found in the soil, while in 1931 apothecia developed in abundance from old sclerotia in the soil. It is suggested that the vegetation in the soil on which the fungus develops may vary from year to year. No evidence was found of *Botrytis* being a cause of the disease, though it is often associated with the *Sclerotinia*. The writer considers that aerial distribution of this fungus is more frequent than was supposed. The occurrence of the disease is more or less sporadic. A. L. S.

Study of Sclerotia.—F. L. STEVENS ("A Comparative Study of *Sclerotium Rolfsii* and *Sclerotium Delphinii*," *Mycologia*, 1931, **23**, 204–22, 16 text-figs.). Diseases due to *Sclerotia* occurred on Delphinium and on several other plants. Comparison was made with *Sclerotium Rolfsii*. Many cultures were made on artificial media, and Stevens has shown that six strains were represented. The methods of work and the results are given in detail. Finally the writer has concluded that there are differences between *S. Rolfsii* and *S. Delphinii* that may be considered specific, but that all are closely related—both species and strains. A. L. S.

Cytological Study.—E. SILVER DOWDING ("The Sexuality of the Normal, Giant and Dwarf Spores of *Pleurage anserina* (Ces.) Kuntze," *Ann. Bot.*, 1931, **45**, 1–14, 1 pl., 10 text-figs.). *Pleurage* is a genus of coprophilous Pyrenomycetes. The ascus contains normally four spores, but occasionally there are giant spores and dwarf spores. The sex of these different spores has been investigated, and the methods and results of cultures are described. Usually a giant spore replaces two normal spores and contains four nuclei, the normal spores being binucleate and bisexual; dwarf spores are uninucleate and unisexual. A mycelium from a normal spore fruits readily, as do mycelia from giant spores. The dwarf spores being uninucleate and unisexual, the mycelium from a single spore is sterile, but when mycelia from different spores are mated, fruits again are readily formed.

A. L. S.

Monilia sitophila.—T. PETCH ("The Bread Mould, *Monilia sitophila* (Mont.) Sacc.," *Journ. Bot.*, 1931, **69**, 67–9). This fungus is now recognized as the conidial stage of *Neurospora sitophila*. The first collection in Great Britain was in 1899, on the rotting seed from a burnt oil mill at King's Lynn. It was identified again as occurring on charred grain after the burning down of Grantchester Mill, near Cambridge. Investigation in America has discovered the perithecial form of this world-wide fungus—*Neurospora sitophila*. The *Monilia* form is evidently identical with the pink mould also recorded after fires in Brazil, New Zealand, and Malaya.

A. L. S.

Study of Claviceps purpurea.—ADELA MCCREA ("The Reactions of *Claviceps purpurea* to Variations of Environment," *Amer. Journ. Bot.*, 1931, **18**, 50–78, 2 pls.). *Claviceps purpurea* forms its sclerotial stage in the heads of various cereals, and has been known as a serious poison since very early times. Cultural experiments were made with various media, the formulæ of which are given. The sclerotia gave rise to mycelium and conidia, and further cultures were made by transplanting these conidia. A description of the cultural conditions is given (the size of the sclerotia and the use of stimulants in the culture, and the influence of temperature, moisture, light, etc.). Much attention is given to oxygenation, with the effects of oxygen on growth. The author has proved that, in saprophytic cultures, sclerotia are developed containing the three chief active principles characteristic of natural sclerotia, viz., ergotoxin, histamine, and tyramine, and these can be thus obtained in economic quantities. The question of sexuality

is also discussed—no proof of heterothallism was found, and evidence points largely to homothallism. The paper is enriched by a list of literature on the various aspects of the study. A. L. S.

Study of Ascomycetes.—BOGDAN VARITCHAK ("Contribution à l'étude du développement des Ascomycetes," *Le Botaniste*, 1931, **23**, 1–142, 20 pls., 20 text-figs.). This paper traverses a wide field from the Hemiasci represented by *Ascoidea* and *Dipodascus* to the consideration of true Ascomycetes. Varitchak derives the great class Ascomycetes from these two representatives of the Hemiasci, and the Hemiasci he traces back to the Phycomycetes. Descriptions of the Hemiasci are given, and the author then passes on to representative Ascomycetes such as *Ceratostomella* spp., and gives a detailed cytological account of their development. *Cordyceps* with its stroma, *Nummularia* and *Xylaria* have also been studied, and the opinions arrived at are given. The author winds up with a chapter on the general conclusions. He adheres to the theory of Dangeard—that the fertilization process takes place at the origin of the ascus. He describes the earlier processes at the formation of the ascogonium as a nuclear fecundation—he sees thus a plasmagamy in the ascogonium, and a karyogamy at the formation of the ascus, the latter being the true sexual fusion. Arguments for and against these views are set out at length. The illustrations are abundant, and a list of 144 numbers completes the paper. A. L. S.

Morphology of Discomycetes.—E. J. H. CORNER ("Studies in the Morphology of Discomycetes. V. The Evolution of the Ascocarp (continued)," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 332–50). As will be seen, this is a continuation of previous studies. The writer represents the fungi as "biologically an upgrade in the colonization of subaerial environment from unicellular aquatic or simple multicellular Phycomycetes to complex Basidiomycetes. Ascomycetes are derived from Phycomycetes and Basidiomycetes from Ascomycetes, though the way is not precisely certain." In the course of the argument Corner describes certain primitive Ascomycetes, such as Plectascales, rather as reduction or juvenescence forms. He rejects the Floridean origin of Ascomycetes: "While Ascomycetes cannot be referred to any algal series, they embody to some extent the equipment of Preflorideæ." Considerable attention is given to the monaxial ascocarp of the Discomycetes here termed a discopodium. He finds that over 99 p.c. of the ascocarps of Discomycetes are variants of the discopodium. The whole paper is a closely reasoned and comparative account of evolution in Discomycetes. A. L. S.

New Hyphomycete.—V. C. E. KENNELLY ("*Pœcilomyces hibernicum*—New Species," *Sci. Proc. Roy. Dublin Society*, 1930, **19**, 513–16, 2 pls.). The new species developed in cultures of dairy butter that was made from sweet cream. The genus is related to *Penicillium* and *Aspergillus*; the conidia, hyaline, then pink, are borne in chains on sterigmata variously arranged in verticils branching from a main stem. It grows in coremia, and it clots milk, later digesting the clots; it is killed by heating to 70° C. A. L. S.

Study of Helminthosporium.—M. MITRA ("A Comparative Study of Species and Strains of *Helminthosporium* on Certain Indian Cultivated Crops," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 254–93, 1 pl., 13 text-figs.). The writer reviews all the species of *Helminthosporium* parastic on economic plants in India, such as wheat, barley, ginger, sugar-cane, etc. He has made cultures and inoculations of eight species under different conditions of moisture, light, etc., and studied their

effect on growth, colour, etc. They mainly produce foot-rot and root-rot in wheat and barley. Mitra has assigned two of them to new species, *H. bicolor* and *H. frumentacei*. A. L. S.

Japanese Uredineæ.—TORAMA YOSHINAGA and NAOHIDE HIRATSUKA ("A List of Uredinales Collected in the Province of Tosa," *Bot. Mag., Tokyo Bot. Soc.*, 1930, **44**, 627–67). The two authors have done considerable research on the Uredineæ of Japan. In this comprehensive list, numbering 255 species, they deal with the families Pucciniaceæ, Melampsoraceæ, Coleosporeaceæ and Uredinales Imperfecti. The collectors and localities are given, and a useful list of 41 papers is added, dealing with the rusts found in Tosa. A. L. S.

South American Rusts.—H. S. JACKSON ("The Rusts of South America Based on the Holway Collections, III," *Mycologia*, 1931, **23**, 96–116, 1 pl., 5 text-figs.). Jackson gives first the rusts on Berberidaceæ, among them species of *Edythea* in which the spores are formed at the apex of hyphæ which emerge through the stomata of the host. Species of a new genus, *Mainsia*, based on *Spirechina* Arth., are described. Generally in these the epidermis is thickened and hypertrophied at the area occupied by the rust. A. L. S.

Physiologic Rusts.—J. MCDONALD ("The Existence of Physiologic Forms of Wheat Stem Rust in Africa," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 235–47, 1 pl., 1 text-fig.). The investigation of physiologic forms of *Puccinia graminis* was undertaken to account for an attack of the rust on a wheat in Kenya that had been considered immune to that fungus. It was argued that the wheat had succumbed to some form not yet detected. The writer describes the method of investigation —the collection of samples from the locality, the growth characters of these samples, etc. It was finally proved that two distinct physiologic forms existed, and comparison is made with results arrived at by American experimenters. One of the forms is considered to be identical with one of the American forms. The author suggests that if the forms of stem rust were standardized, much time and loss could be avoided by growers. A. L. S.

Rust on Valerian.—JAN MUSZYŃSKI ("Das massenhafte Auftreten des Baldrianrostes auf der Kultivierten *Valeriana officinalis* in Wilno," *Acta Soc. Bot. Pol.*, 1930, **7**, 89–92, 3 text-figs., Polish with German summary). The rust, *Puccinia commutata* Syd., developed in great abundance in 1929 on valerian cultivated in the Medical Garden, Wilno. The host plant had been cultivated since 1923 without any sign of disease, but in the hot, dry summer of 1929 the plants were badly infected. The light sandy soil had been occupied in 1928 by potatoes and oats. Spraying with soda solution proved an effective remedy.
A. L. S.

Evolution in the Uredinales.—H. S. JACKSON ("Present Evolutionary Tendencies and the Origin of Life-Cycles in the Uredinales," *Mem. Torrey Bot. Club.*, 1931, **18**, 5–108). The writer disclaims all intention to throw light either on the origin of rusts or of heterœcism in the order; his aim is to examine the present trend of development. He notes, first of all, that the host has had great influence on the differentiation and origin of species, and that specialization to host arose at an early stage. He then proceeds to discuss the species that exhibit an unstable condition: such species have been examined, and a great variety of developments have been followed. The whole paper is a summary of work done in this very variable order and on the conclusions arrived at: the

importance of Craigie's work on pycnidia is emphasized. He sums up that "ancestral rusts, like the older species in existence to-day, were heterœcious, heterothallic, and pleomorphic." He traces the descent of the various forms to one or other of these large divisions. A list of literature and an index of genera and species referred to in the text complete the paper. A. L. S.

New Rust Species.—KOGO TOGASHI and FUSNEGI ONEUMA ("A New Species of Blastospora," *Bot. Mag., Tokyo*, 1931, **45**, 4–7, 3 text-figs.). The fungus appeared on the leaves of *Smilax*, and was found to be a new species, *Blastospora Itoana*. It formed large yellow or brownish spots on the surface; the teleutosori developed on the under surface. So far as known, only three other species have been recorded, one from Japan, the others from India. A. L. S.

Australian Rust Studies, III.—W. L. WATERHOUSE (*Proc. Linn. Soc., N.S.W.*, 1930, **55**, 596–636). The aim of the research was to discover if immunity to rusts could be secured by crossing wheat plants. A long account is given of the work for a number of years. Lists are given of the "parents," the "grains set," and the "pollinations made." The writer records 75 p.c. of successful crossing, and of the comparative resistance of the resulting plants. They have proved the inheritance of resistance to *Puccinia graminis-Avenæ*, which points to the operation of a single dominant factor for resistance. It is considered that definite resistance may ultimately be obtained. A. L. S.

Peach Rust.—M. C. GOLDSWORTHY and RALPH E. SMITH ("Studies on a Rust of Clingstone Peaches in California," *Phytopathology*, 1931, **21**, 133–68, 10 text-figs.). Peach trees are extremely susceptible to disease, and suffered severely, during three years previous to 1928, from rust disease in California. Serious economic loss was caused, as defoliation of the trees took place, and the fruit was disfigured and ruined for canning purposes. The special rust here dealt with, so far as determined, is confined to the Sacramento Valley. Full accounts of the rust and of the various conditions are given, special attention being devoted to moisture relations, temperature, etc. The uredo stage alone has been observed in the valley, and overwintering is achieved mainly by twig infections, which originate in autumn and develop uredosori in spring. Spread of the disease thenceforth depends on rainfall and humidity, as the spores require three hours in a moisture-saturated atmosphere for germination, and their viability is limited to about six weeks. The identity of this rust with that on the prune is discussed, the latter produces teleutospores. Methods of combating the disease are discussed. It has not appeared in the valley since 1927. A. L. S.

Contributions to Phytopathology.—JAKOB ERIKSSON ("Phytopathologische Mitteilungen, II," *Arkiv. för Botanik*, 1931, **23**, N. 7, 1–18, 6 pls., 4 text-figs.). Eriksson discusses first the growth of the spore tube in the cells of the host plant. He deals with *Puccinia malvacearum* on the leaves of the hollyhock. He has described the various stages of growth after infection. He considers that there is a mingling of mycoplasma with the cell plasma, and that the plasma passes to neighbouring cells, and finally circumscribed spots are formed on the outside of the leaf; these pustular spots appear from 12–14 days after infection. Eriksson discusses the formation and function of the nucleoli of the fungus hyphæ: these multiply by division—no karyokinesis has been found to take place. Later he contributes his notes on the overwintering of *Puccinia Ribis*. He finds here also an intimate symbiotic association of the normal protoplasm of the host with the fungus plasma of the parasite, forming a mycoplasma which persists from year to

year. Overwintering is thus secured by this plasma or by teleutospores. The mycoplasma forms thick-walled resting cells—chlamydoten (chlamydospores), which overwinter in the leaf buds. A. L. S.

Mushroom Culture.—J. FRANKLIN STYER ("Nutrition of the Cultivated Mushroom," *Amer. Journ. Bot.*, 1930, **17**, 983–94). This is the continuation of work reported previously, and is an attempt to discover the most exact and most favourable substances for mushroom cultivation. Many experiments were made and are duly recorded. The author concludes that the fungus can grow on a great variety of substances, and that the mycelium grows upon complex organic matter by reason of the production of sugars, but that cellulose is only slowly decomposed. The mycelium is intensely aërobic, and the spores germinate more quickly in spore masses. Finally it has been proved that the organism can probably make use of nearly all the substances in manure, including lignin. A. L. S.

Yorkshire Basidiomycetes: Lepiota.—F. A. MASON (*The Naturalist*, 1931, 45–50, 2 text-figs.). Mason gives a general description of the species of *Lepiota*, their habitat and occurrence. Of the 60 known British species, about half have been found in Yorkshire. The author passes these in review, giving new records and a complete description of the species *Lepiota lilacea*. A. L. S.

Sexuality of Coprinus.—A. J. P. OORT (*Recueil trav. bot. néerlandais*, 1930, **27**, 85–148, 3 pls., 5 text-figs.). Oort has studied the various aspects of this subject in great detail by means of cultures. He sums up the conclusions he has come to as—(1) Two mycelia without similar factors are similar in growth to the haploid mycelium. There is seldom repulsion and little tendency to haploid fruit formation. (2) Two mycelia with dissimilar A factors hinder each other; there is formation of mixed mycelia and little development of haploid fruit formation. (3) Two mycelia with dissimilar B factors repulse each other, but the tendency to fruit formation is heightened. Finally it is stated that in many- or in two-spore cultures the mycelia containing common factors form frequently abnormal clamp-connections. These mycelia do not exhibit the normal diploid habit, and never form diploid fruit bodies. A. L. S.

Study of Amanita.—S. M. ZELLER ("*Amanita calyptrata* and *Amanita calyptroderma*," *Mycologia*, 1931, **23**, 225–6). These two species grow in Western America; they are related to the European *A. cæsarea.* These American species closely resemble each other; both species are edible. The main distinction is the greenish tinting of pileus and gills in *A. calyptrata*, and the thick double volvate cup at the base of *A. calyptroderma*. A. L. S.

Study of Ganoderma.—S. R. BOSE ("Tissue-Culture of *Ganoderma colossus* Fr.," *Journ. Dept. Sci.*, 1930, **10**, 1–2, 2 text-figs.). Bose describes the development of the fungus in artificial cultures from a small fragmentof the sporophore to the formation of spores and the peculiar double-walled spores of the species, though without the formation of basidia. Similar results were obtained by transference to blocks of sterilized wood. A. L. S.

Luminous Fungi.—S. R. BOSE ("Relation of Sunlight to the Light of Luminous Wood," *Die Naturwissensch.*, 1930, **18**, 1 page, reprint). Bose kept a piece of luminous wood of *Sterculia* giving out light for eight months until the rise of summer temperature, when the light ceased. Autoclaved wood gave out no light, as the hyphæ were killed during the process of sterilization. He found also by experiment that luminosity depended on the general stimulation of the living hyphæ in the presence

of sunlight, but under a powerful sun luminosity diminished quickly. Moisture also is necessary for its production. He terms the luminescence a "chemiluminescence."
A. L. S.

New Luminous Fungus.—FRIEDRICH BOTHE ("Ein neuer einheimischer Leuchtpilze," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 394–9, 2 text-figs.). The fungus *Mycena tintinnabulum* Fr. was found with others destroying wood, and it proved to be a luminous species. It is only the mycelium that gives out light, and only while still colourless; when it becomes brown, the light disappears. Rhizomorphs were not formed. A. L. S.

Poria in America.—L. O. OVERHOLTS ("Diagnoses of American Porias. III. Some Additional Brown Species, with a Key to the Common Brown Species of the United States and Canada," *Mycologia*, 1931, **23**, 117–29, 3 pls.). Overholts gives full revised diagnoses of the five *Poria* species added to those previously recorded. In the key to the brown Porias he has included forms that may most probably be resupinate stages of *Trametes, Fomes*, and *Polyporus*, almost impossible to place with assurance in their respective genera. A. L. S.

Notes on Irpex.—K. CEJP ("Notes on Iowa Species of the Genus *Irpex*," *Mycologia*, 1931, **23**, 130–3, 1 text-fig.). The author comments on the difficulty of defining the exact systematic position of *Irpex*. Usually it is placed in Hydnaceæ, but certain species approach near to *Lenzites* or *Dædalea*. Most of them are resupinate—the receptacle effused on the substratum—but others are effuso-reflexed and marginate. Five species are described, all known as American species.
A. L. S.

Schizophyllum on Apples.—F. D. BAILEY and S. M. ZELLER ("The Occurrence of *Schizophyllum commune* on Green Apples," *tom. cit.*, 154–5, 1 text-fig.). The fungus grew freely in Oregon on apples that had fallen from the trees and gradually withered—a new type of host for the fungus. A. L. S.

Volvaria speciosa.—JOHN DEARNESS (*tom. cit.*, 152–3). A note by Dearness on the edibility of this fungus. The writer gathered it in fine condition and proved its non-poisonous nature, but the edible quality was not high. He gives a detailed description to distinguish it from *V. gloiocephala*, a poisonous species.
A. L. S.

Research on Battarrea.—G. MALENÇON ("Recherches complémentaires sur les basides du *Battarræa Guicciardiniana* Ces.," *Ann. Crypt. Exot.*, 1930, **3**, 194–9, 1 pl.). The author describes a peculiarity of the basidia in that an outer gelatinous layer covers the tips of the basidial hyphæ and only breaks away when the sterigmata begin to appear. The gelatinous matter serves two functions: it stores up moisture—a necessity in the desert conditions of the habitat—and as the gelatin contains pectin, there is thus a probable reserve food present. The methods of research and the stains used are described. A. L. S.

Abnormal Fungus Growth.—E. ULBRICH ("Ueber den vermeintlichen Parasiten, *Poria agaricicola* (Ludw.) Sacc. auf *Amanita*-Arten," *Ber. Deutsch. Bot. Ges.*, 1930, **48**, 465–9, 1 pl.). The author found a fungus similar to one previously described as *Poria agaricicola* on a specimen of *Amanita rubescens*. Careful examination of the abnormal hymenium of *Trametes*-like furrows and pores led to the conclusion that it was an unusual development of the host species. The absence of light could have had no part in the abnormality, which was probably caused by excessive moisture. A. L. S.

Danish Micromycetes.—J. Lind ("Danske Micromycter," *Bot. Tidskr.*, 1930, **41**, 210–26, 2 pls.). The author continues his list of fungi for Denmark. In this paper many Pyrenothecia and Fungi Imperfecti are dealt with; habitat and locality are given. Many are parasitic. The plates give representations of some of the rarer fructifications and spores. A. L. S.

Mycological Notes.—C. A. Jorgensen ("Mykologiske Notitser," *tom. cit.*, 227–39, 22 text-figs.). A selection of somewhat rare microfungi are described and, in most cases, figured; biological notes are also given. A. L. S.

Ceylon Fungi.—T. Petch ("Revisions of Ceylon Fungi, Part IX," *Trans. Brit. Mycol. Soc.*, 1931, **15**, 247–54). The author has published descriptions and notes of a varied series of fungi, continued from a similar publication in the *Annals of the Royal Botanic Gardens, Peradeniya.* New descriptions are given and a history of the specimens; many puzzles in nomenclature are cleared up concerning both microfungi and some of the larger Basidiomycetes. A. L. S.

Fungal Growth Forms.—Mary J. F. Gregor (Wilson) ("A Comparative Study of Growth Forms within the Species *Dermatea livida* (B. & Br.) Phillips," *Ann. Bot.*, 1931, **45**, 73–90, 1 pl., 5 text-figs.). The writer has compared, by culture and otherwise, the different species of *Dermatea* that occur on the bark of conifers; they are *Dermatea livida, D. eucrita, D. laricicola, D. abietina,* and *D. Pini.* Her contention is that the size of the spores, so often the distinguishing character, is apt to vary according to the conditions of growth. She found that the different species enumerated are a continuous series of forms, all being united by her under *D. livida.* The conidial stage is *Myxosporium abietinum,* and, in addition to normal conidia, minute non-germinating spores were produced; the length of these spores varied also slightly in the different forms. No case of true pathogenicity was proved, and the writer concludes that *Dermatea livida* is, in general, purely saprophytic, though it may occasionally function as a weak parasite. A. L. S.

Fungi on Vegetative Matrix.—José Benito Martinez ("Algunos datos acerca de hongos que viven sobre matriz vegetal y principalmente leñosa," *Bol. Real. Soc. Esp. Hist. Nat.*, 1930, **30**, 323–7). The author has grouped together a number of fungi that grew on decaying vegetable matter—trunks or branches of trees, decaying leaves, etc. A few Basidiomycetes are recorded along with specimens of Uredinales and one of Ustilaginales. Several Ascomycetes are listed, with various notes on the species, and also species belonging to other groups. They all formed part of the cryptogamic herbarium of phytopathology in the Institute of Forest Investigations and Experiences in Madrid. A number of the species determined were new to Spain. A. L. S.

Contribution to Spanish Mycology.—Luis M. Unamuno, O.S.A. ("Nueva aportación a la micologia española," *tom. cit.*, 287–301, 4 text-figs.). The specimens here listed of micromycetes were collected in the neighbourhood of Salamanca, and belong to the Uredineæ, a few Ustilagineæ and Oomycetes, with many Fungi Imperfecti. The author records 79 species, many of them new to science or new to Spain. One genus and species, *Kellermania Hordei* Unam., is also new to the country. A. L. S.

Variation in Fungi.—B. Barnes ("Induced Variation in Fungi," *Journ. Quekett Micros. Club*, 1931, **16**, 167–76). An account is given of the variations that may occur in fungi when grown in artificial conditions. The growth of *Eurotium herbariorum* was followed under different conditions of temperature and of media,

and the effects produced were carefully followed. Many remained true to type, but occasional abnormal colonies were formed, and these variants are described. Some of them reverted to type, but three definite variants were established :—(1) the conidia and perithecia differed from the normal in form, shape, and colour ; (2) a strong tendency to difformed fructifications ; and (3) variants that formed conidia but no perithecia. Other characters were present, and they persisted in renewed cultures. Similar experiments were made with *Botrytis cinerea*, and two persistent variants were formed. These are described and compared.

A. L. S.

Study of Inheritance.—DOROTHY M. CAYLEY ("The Inheritance of the Capacity for showing Mutual Aversion between Mono-Spore Mycelia of *Diaporthe perniciosa* (Marchal)," *Journ. Genet.*, 1931, **24**, 1–63, 1 pl.). Cayley has studied this problem from every aspect by repeated cultures, though, as she states, it still remains complex. She finds that there exist different forms of heterothallism—(1) simple haplo-heterœcism (true sex heterothallism) and a haplo-heterœcism together with physiological heterothallism other than sex. Her conclusions have been reached by cultures of the fungus spores. She has worked on the die-back fungus *Diaporthe perniciosa*, but evidently, she considers, with two forms, probably closely allied but distinct species. They both have, and inherit, the capacity for showing interracial aversion, but intra-perithecial aversion has only been found in the second form, in which a second type of filiform pycnospores are present. The whole subject is worked out in great detail, and the results set out in various tables.

A. L. S.

Skin Fungi.—ALDO CASTELLANI ("The Fungi Found in North American Blastomycosis : their Plurality of Species," *Brit. Journ. Dermat. and Syph.*, 1930, **42**, 365–74, 1 pl. col., 14 text-figs.). The term "blastomycosis" covers all skin diseases due to yeasts or yeast-like budding fungi. The author here defines and describes certain forms under a new genus, *Blastomycoides*, with the species *B. immitis*, *B. dermatitidis*, *B. tulanensis*, and *B. lanoginosis*, and he places the genus among the Fungi Imperfecti. He describes their development in artificial cultures and their characters in skin lesions. Artificial cultures are necessary for determination.

A. L. S.

Skin Fungus.—C. W. EMMONS ("Observations on *Achorion gypseum*," *Mycologia*, 1931, **23**, 87–95, 2 pls., 1 text-fig.). A culture study of this fungus, *Achorion gypseum*, which causes lesions on the skin, was studied in the Laboratory of Medical Mycology, Columbia University, and later the same fungus was found on the scalp of a young boy. There are two types of spores—small simple conidia and elongate septate conidia. Cultures from single isolated spores of each type were similar. The small conidia are sometimes binucleate ; the hyphal cells and the macroconidia are multinucleate. It was found that it grew well on nail parings and on horn, in which it destroyed the substance.

A. L. S.

New Yeast.—R. CIFERRI ("Contributions to the Classification of Torulopsidaceæ. I. An American Variety of the *Torulopsis minuta*," *tom. cit.*, 140–6). This yeast was discovered in soil cultures from Minnesota and was provisionally classified as *Torula glutinis*. Ciferri describes the cultures he has carried out and the colour—changing from English red to chestnut and auburn when the colony is old. The morphological and biochemical characters are described, and the yeast finally classified as *Torulposis minuta* var. *americana*.

A. L. S.

Notes on a Soil Fungus.—H. L. JENSEN ("Notes on a Cellulose Decomposing Soil Fungus of an Unusual Character," *Proc. Linn. Soc., N.S.W.*, 1930, **55**, 699–707, 1 pl.). The fungus was discovered in the course of studying the microbial decomposition of farmyard manure in the soil. It is probably a species of *Botryosporium* (Hyphomycetes). A full account is given of the fungus itself and of its physiological characters: it requires a somewhat high acidity, but in neutral or alkaline solution it exerted a very strong decomposing activity. Jensen considers it of great importance in the soil. A. L. S.

Fungi found in Butter.—M. GRIMES and V. C. E. KENNELLY ("A Study of Fungi found in Butter," *Sci. Proc. Roy. Dublin Soc.*, 1930, **19**, 549–69, 2 pls.). The fungi were isolated from butter made from sweet cream and prepared for the market; they were then developed in nutrient lactose agar. The most prevalent forms found were species of *Penicillium*, *Oidium lactis*, *Aspergillus*, *Cladosporium* and *Phoma*. In all, 29 species were determined, but the great majority occurred rarely. The species are all described, and the probable sources of contamination are discussed. Salt butter is largely free from moulds: 20 p.c. salt kept the butter entirely free from contamination. An addition of 2·3 p.c. of salt is advised as necessary to inhibit the fungus growths. It was noted that the moulds differed somewhat from published descriptions, and it is considered that the variation in these Irish fungi is a result of insularity, and that they have developed characteristics of their own. A. L. S.

Synapsis in Fungus Hyphæ.—M. and MME. FERNAND MOREAU ("Les synapses des champignons supérieurs," *Bull. Soc. Bot., France*, 1930, **77**, 513–17, 35 text-figs.). The authors describe the appearance of the minute deposits of protoplasmic bodies on the adjacent walls of cells in the higher fungi, including also a few of the larger lichens. The synapses indicate the region of perforations, enabling the two cells to communicate: "They represent a superficial differentation of cytoplasm in the neighbourhood of another cytoplasm, and, probably, the result of a reaction caused by the near association between two cytoplasms."
A. L. S.

Mycorrhiza.—M. C. RAYNER ("Mycorrhiza in Relation to Tree Growth," *Empire Forestry Journ.*, 1930, **9**, 182–9). Rayner reviews the opinions held with regard to the value of mycorrhiza in relation to the growth of trees. The mycorrhizal habit is certainly fixed and invariable in certain groups of plants, and the author cites the evidence and the results obtained by cultures of the trees with and without the complement of the fungus. She decides that "it is clear that the production of normal and functional mycorrhiza by many trees may play an important part in maintaining healthy growth." The value of mycorrhiza is even more evident in young trees. A. L. S.

Parasitic Fungi New for Bulgaria.—D. ATANASOFF, D. DODOFF, and I. KOVACHEVSKY (*Bull. Soc. Bot., Bulgarie*, 1931, **4**, 36–43; Bulgarian with British summary). The fungi listed belong to the group of microfungi and occur mostly on leaves. These are described at length. In addition there are listed 26 parasitic species or new host plants, but not yet reported for Bulgaria. A. L. S.

Diaporthe on Larkspur.—FREDERICK A. WOLF ("*Diaporthe* Blight of Larkspur," *Phytopathology*, 1931, **21**, 77–9, 2 text-figs.). The larkspur affected is *Delphinium Ajacis* L. The blight appears on the lower leaves at the flowering stage: they are dotted with black pycnidia, the crown and the uppermost roots

being enveloped in a cottony weft of mycelium during rainy periods. The pycnidial stage has been identified as a *Phomopsis*, and alone appears on the living parts of the plant; the ascigerous stage, finally recognized as *Diaporthe Arctii*, develops on the stems after decay has set in. Culture experiments were carried out with the different spore stages. Infections resulted from inoculation with ascospores, and with conidia from ascospore cultures. A. L. S.

Pathology of Maize.—L. W. Durril (*Bull. Torrey Bot. Club*, 1930, **57**, 233–7). From this paper we learn that some of the earliest work was on smut in Illinois (1880). Information is given on the occurrence and treatment of diseases of maize crops, both fungoid and bacterial. These diseases are of great economic importance, and often cause 20 p.c. loss. A. L. S.

Study of Cotton Root-Rot.—J. J. Taubenhaus, Walter N. Ezekiel, and J. P. Lusk ("Preliminary Studies on the Effect of Flooding on *Phymatotrichum* Root-Rot," *Amer. Journ. Bot.*, 1931, **18**, 95–101). It had been noted that *Phymatotrichum omnivorum* was rare on land subject to periodic overflows. An investigation was made, and the research workers have proved that submergence may be fatal to the fungus. But there must be deep penetration of the water to reach the lowest roots, and also the experiment may fail owing to the presence of sclerotia that are not easily destroyed, though in normal and favourable conditions the fungus can be eradicated by submergence for three days. Further studies are in progress. A. L. S.

Fomes Disease of Beech.—E. Ulbrich ("Ueber Alter, Dickenwachstum und Fomes-Befall einer Rotbuche (*Fagus silvatica* L.) am Faulen Ort in der Gramzower Forst," *Verh. Bot. Ver. Prov. Brandenburg*, 1930, **72**, 109–13). The author has carefully examined the stump of an affected beech—its orientation, position in the forest, and its growth history as revealed by the yearly rings. It dates back to 1650, and a record is given for every 50 years as to the internal condition of the trunk. During the first 130 years growth in girth was slow; after that there was more advance. Then—from 1829 to 1929—there was a distinct loss of energy, and from 1860 onwards the rings showed great irregularity, owing to fungus attack. The tree was most affected on the side towards the wood.
A. L. S.

Disease of Sugar Beets.—Dewey Stewart ("Sugar-Beet Yellows caused by *Fusarium conglutinans* var. *Betæ*," *Phytopathology*, 1931, **21**, 59–70, 4 text-figs.). The author here describes a newly discovered *Fusarium* disease on sugar-beet roots. Following the attack, the leaves become yellow; the roots show no outward sign, but a section across shows brown discoloration and rot of the vascular system. The action of the disease, however slight, is to lower the sugar content and seriously impair the economic value of the roots. Careful observation of cultures has identified the organism with *Fusarium conglutinans*, though differing in varietal characters. It is most virulent on seedlings, though not immediately deadly. A. L. S.

Rose Disease.—D. E. Green ("Experiments and Observations on the Incidence and Control of the Black-Spot Disease of Roses," *Journ. Roy. Hort. Soc.*, 1931, **56**, 18–30, 4 pls.). The spot disease of roses due to the fungus *Diplocarpon Rosæ* is described. It appears as brownish-black specks which gradually enlarge to circular blotches with a radiating edge, or the disease may follow the course of the larger veins. At first pycnidia are formed. The ascospore stage appears in spring and reinfects the rose trees. Most of the paper is taken up with an account

of experiments to control or eradicate the disease—by change of fertilizers and by spraying and dusting the foliage. Bordeaux mixture spraying was the most effective agent. A. L. S.

Spanish Microfungi.—LUIS M. UNAMUNO ("Hongos microscópicos de los Caballeros (León)," *Bol. Real Soc. Esp. Hist. Nat.*, 1930, **30**, 207–15). The author publishes the fungi in this paper as a further contribution to the mycological flora of Barcelona; many of them were collected by P. Antonio Alvarez. The list comprises 51 species. Most of them, such as the Uredineæ, etc., are parasitic on leaves, branches, etc. A number are new to science, others are new to the Spanish flora. *Darlina filum*, a well-known parasite on sori of *Puccinia*, is recorded, and also a new species, *D. vulpiæ*, found on the uredosori of *Puccinia graminis*. Six of the species are new to science. A. L. S.

Enemies of Cultivated Plants.—JULIÁN ALONSO ("Datos sobre los enemigos de las plantas cultivadas en Galicia," *tom. cit.*, 217–22). Some of the enemies here recorded are mollusca and insects, but most are parasitic fungi. The data are taken from a collection of these in the National Institute of Agriculture in Galicia. The temperature and moisture conditions in Galicia are described as favourable to agriculture, and the necessity for combating the pests is less pressing than in many other places. A. L. S.

Timber Decay.—K. ST. G. CARTWRIGHT and W. P. K. FINDLAY ("The Diagnosis of Decay in Timber," *Empire Forestry Journ.*, 1930, **9**, 190–203, 4 text-figs.). The authors present a guide to the detection of fungus disease in trees, and they also give a series of keys of identification of fungus cultures:—(1) on coniferous timber; (2) on oak; (3) on ash. The characters selected are visible to the naked eye. They also describe the method of preparing the cultures. Prune extract agar is frequently used as medium for the first culture. A. L. S.

Peach Scab.—D. E. GREEN (*Gard. Chron.*, 1931, **89**, 151–2, 1 text-fig.). Green draws attention to the disease of peaches and nectarines due to the fungus parasite *Cladosporium carpophilum*. It appears on the leaves in the form of brown specks. On the fruits it takes a scabby appearance of brown markings or spots which lead to cracking and the exuding of gum; the disfigurement is a great disadvantage, though the interior is untouched. The fungus overwinters on the current year's shoots, and should be attacked at that stage by dusting or by other methods. A. L. S.

Diseases of Snowberry.—W. H. DAVIS ("Anthracnose, Alternariose, and *Botrytis* Rot of the Snowberry," *Mycologia*, 1931, **23**, 159–90, 5 pls., 5 text-figs.). Davis has carefully studied three different diseases of the snowberry, all of them causing discoloration and disfigurement of the white berry. Cultures were made, and in each case the offending parasite was followed throughout its life-history. (1) Anthracnose is caused by an ascogenous fungus, *Glomerella rufomaculans*, and by its conidial stage, *Glœosporum rufomaculans*. The disease was first noted in autumn, when conidia appeared on the berries, turning them red or black, followed in spring by perithecia. It is supposed that the hyphæ overwintered in the buds. The different stages are described at length, and remedies, such as spraying, dusting, etc., are suggested. (2) Alternariose can be distinguished from Anthracnose in that the berries became yellow or brown. It parasitizes berries, bark, and bud scales. It is due to the Hyphomycete *Alternaria solani*. *Botrytis* disease (due to *B. vulgaris*) attacks the leaves as well as the berries. In three days after inoculation

the leaves were turned brown; the berries were entirely discoloured after five days. Full descriptions of fructification, etc., are given and remedies suggested.

A. L. S.

Diseases caused by Elsinoe.—ANNA E. JENKINS ("Scab of *Canavalia* caused by *Elsinoe Canavaliæ*, and Lima Bean Scab caused by *Elsinoe*," *Journ. Agric. Research*, 1931, **42**, 1–12, 4 pls.; 13–23, 5 pls.). Two diseases of beans have been examined, one on *Canavalia* and the other on *Phaseolus* (Lima bean). In each paper the appearance and course of the disease on the leaves or on the pods are fully described. *Elsinoe Canavalliæ* has occurred in Ceylon, Malay, etc., while the more recently discovered Lima bean disease has been reported from Cuba and Porto Rico. It is tentatively suggested that the two fungi may be identical. *Elsinoe* is an Ascomycete of the Myriangiales order. Full descriptions are given, more especially of the Lima disease, which was examined and grown on artificial media. The fungus is of economic importance, as it disfigures the pods and ravages the leaves, but it is not known to have affected the beans inside the pods.

A. L. S.

Sugar-Cane Disease.—C. N. PRIODE ("Target Blotch of Sugar-Cane," *Phytopathology*, 1931, **21**, 41–57, 7 text-figs.). The disease is one of several caused by a fungal parasite, *Helminthosporium* sp. The specific relation has not been definitely established. The disease was first observed in Cuba, and has been worked out at the Cuba Sugar Club Experiment Station, Baraguá, Cuba. The appearance of the disease is described: it begins as a tiny red speck, later developing necrotic blotches of irregular rings on the leaves, hence the descriptive name "target blotch." The attacks of the fungus are most severe in the winter season. Many culture experiments were carried out, and the growth characteristics are fully described; it is easy to isolate, and grows and fruits readily in plate cultures. The effects produced by changes in the culture media are also described. Many varieties of the sugar-cane are attacked.

A. L. S.

Lettuce Disease.—L. OGILVIE and B. O. MULLIGAN ("A Leaf-Spot Disease of Lettuce due to *Pleospora herbarum*," *Gard. Chron.*, 1931, **89**, 35, 1 text-fig.). The disease is common in the West of England, though not serious enough to warrant control measures. The spots become brown in colour and may fall out. *Macrosporium sarcinula* is found on these spots, the perfect stage being *Pleospora herbarum*.

A. L. S.

Disease of Populus.—ERNST J. SCHREINER ("Two Species of *Valsa* causing Disease in *Populus*," *Amer. Journ. Bot.*, 1931, **18**, 1–29, 5 pls.) The species of *Valsa* are mostly saprophytic fungi; a few are facultative parasites, among them *Valsa sordida* and *V. nivea*, which cause injury to poplars. Schreiner induced growth of *Valsa sordida* on a large number of other trees, usually dead twigs, proving their essential saprophytism. Full particulars of the various cultures are given and the conclusions come to by the writer. The pycnidial stage is a *Cytospora* found on dead wood. *Valsa sordida* is the more vigorous of the two *Valsæ*, and has been found on many kinds of poplars, causing serious damage. It grows on the bark and wood, killing the cambium, so that the branch or even an entire young tree may be killed. *V. nivea* is of slower growth and not so virulent as *V. sordida*.

A. L. S.

Study of Cercospora.—R. CIFERRI and S. C. BRUNER ("*Cercospora bataticola* n. sp., Parasite of the Sweet Potato in America," *Phytopathology*, 1931, **21**, 93–6, 1 text-fig.). A disease of the sweet potato due to *Cercospora batatæ* has

been known as occurring in Africa and various Eastern countries. A fungus on the same host has been reported from Florida, Cuba, Santo Domingo and the Philippines. The writers have made a comparative study of the blotches on the leaves as well as of the size of the spores, which in the Asiatic species are longer and broader, with more septæ. They have decided that the American fungus is a new species, *Cercospora bataticola*. A. L. S.

Diseases of Grain Crops.—L. R. TEHON ("Epidemic Diseases of Grain Crops in Illinois, 1922–1926," *Illinois Bull. Nat. Hist. Survey*, 1930, **17**, 1–96, 103 text-figs.). The author describes his work in connection with these diseases as "The Measurement of their Prevalence and Destructiveness, and an Interpretation of Weather Relations based on Wheat Leaf Rust Data." He gives his method of estimating the extent of infection and damage done, the number of divisions into which the grain-producing territory is divided, and the acreage occupied by the cereals. The different species of *Puccinia* that attack cereals are listed, as well as the damage that is caused. The smuts on oats, barley, and corn are also dealt with, as well as various "scabs," blights, etc. A summary is given of all the data showing the prevalence and destructiveness of the various parasites. Finally the relations of moisture and temperature to the incidence of disease are discussed, as it has been proved "that there is a well-defined relation between intensity of attack and annual mean temperature and yearly totals of rainfall."
A. L. S.

Diseases of Fruit Trees.—L. R. TEHON and GILBERT I. STOUT ("Epidemic Diseases of Fruit Trees in Illinois, 1922–28," *op. cit.*, 1930, **18**, 415–502, 21 text-figs.). As in the previous paper on cereals, the observers made an estimation of the area occupied by fruit trees, and the number of trees planted. Apple trees are the most numerous and important, and disease mainly attacks the leaves; but attention is also given to the fruit attacked, and the parasitic fungi are determined. They are mainly Fire-blight, Rust, Blotch, Scab and Black-rot, the last-mentioned due to *Physalospora malorum*, which attacks leaves, twigs, and fruits. Diseases of pear, peach, cherry and plum are also dealt with. In the final summing up the authors consider an epidemic under two primary aspects: (1) the prevalence of the disease, and (2) the intensity of the attack. They do not claim to have discovered any general law except that which seems to prevail between pomaceous and drupaceous fruit trees—when one type is attacked, the other largely escapes. A year that favours disease on apples and pears is not favourable to the growth of fungi on the stone-fruits—cherry, plums, etc. The prevalence of these diseases, as in the case of cereals, is governed by moisture, temperature, etc. A. L. S.

Phyllosticta and Bacteria.—G. NICOLAS and MLLE. AGGÉRY ("Nouvelles observations sur *Phyllosticta Daphniphylli* Nicol. & Agg. et aggravation de son action par des bactéries," *Comptes-rendus Acad. Sci.*, 1930, **191**, 1376–8). The authors give further description of the parasitic action of the *Phyllosticta* on the host plant. They have discovered that the fungus overwinters on the bark of the tree. They have also proved the presence of living bacteria in the plant cells, sometimes alone but frequently in connection with the deformed tissue due to the action of the *Phyllosticta*. The fungus prepares the way and the bacteria follow. When alone, they penetrate further into the tissues than when associated with the fungus, as the host plant, irritated by the fungus, forms a "bark" that keeps out both the parasitic organisms. After penetration the bacteria travel by the vessels to the leaves, destroying their development. A. L. S.

Prevention of Disease.—RAIMUND H. MARLOTH ("The Influence of Hydrogen-ion Concentration and of Sodium Bicarbonate and Related Substances on *Penicillium italicum* and *P. digitatum*," *Phytopathology*, 1931, **21**, 169–98). There are two methods of preventing the growth of the above moulds on stored and packed *Citrus* fruits: treatment with borax and treatment with sodium bicarbonate, the latter the more effective against blue mould (*Penicillium italicum*), but not so much so against green mould (*P. digitatum*). The aim of the investigation was to decide the effect of the bicarbonate in preventing the mould decay. It was found that the bicarbonate ion is toxic to fungi, "for its solution gives a *p*H value of $\pm$ 8·4, and that when the hydroxyl-ion concentration in a solution is large enough to give a *p*H value of 10+, the toxic property of such a solution lies in the hydroxyl-ion." The thin film of sodium bicarbonate left on the rind after treatment acts on the protoplast of the fungus spore and germinating tube, preventing all further growth of the mould. A. L. S.

Lichens.

Siamese Lichens.—ROBERT PAULSON ("Lichens from Kaw Tao, an Island in the Gulf of Siam," *Journ. Siam. Soc. Nat. Hist. Suppl.*, no. 2, 1930, **8**, 99–101.) The lichens, with a few exceptions, are crustaceous species, and thickly cover the bark of small trees of evergreen forest. Paulson determined one species new to science, *Phyllopsora viridis*, which he has described, and he gives a further account of *Parmelia australiensis*, a rare species originally from Australia, now found again at two localities in the Gulf of Siam. A. L. S.

Russian Lichens.—P. N. NIKOLSKY ("Lichens New to the Vialka Region," *Bull. Jard. Bot. Princ. U.S.S.R.*, 1930, **11**, 325–9, Russian with German summary). The region examined was the Medevok pine forest in North-East European Russia. The collection was made by Nikolsky and by A. D. Fokin, and includes 52 species. all new to that district. Among the rarer species are noted: *Parmelia fuliginosa* var. *Cactavisens* and *Cladonia pityrea*, also *Rinodina Conradi*, the first record for Russia. A. L. S.

New or Rare Russian Lichens.—A. N. OXNER ("Neue und wenig bekannte Flechtenarten in der U.S.S.R. Auszug," *tom. cit.*, 1930, **11**, 56–68, Russian with German *résumé*). In the short *résumé* of the paper Oxner states that most of the material he collected himself; some specimens he found in herbaria. They are mostly from Southern Russia. Ecological notes are included. A. L. S.

Saxicolous Lichens.—M. and MME. FERNAND MOREAU ("Étude systématique, écologique et sociologique des lichens saxicoles des environs de la station biologique de Besse (Puy-de-Dôme)," *Bull. Soc. Bot., France*, 1930, **77**, 479–90). The authors have devoted this paper to a study of saxicolous lichens of the "Massif-Central" of France. The rocks are of volcanic origin, and reach a height of 1,000 m. They have, however, chiefly studied the stone walls that encircle the various domains. These are formed of massive slabs of stone built up without cement. The upper layers are exposed to sun, wind, rain and snow; the lower are more sheltered, and, towards the base, an encroaching ground vegetation offers new conditions. A long list of lichens follows, with biological notes, and, naturally, crustaceous forms predominate. In conclusion they note that, with the exception of a few Collemaceæ, the lichens are xerophytic in character. The pioneers in colonization are species of *Placodium* and *Candelariella* on worked stone, and *Candelariella vitellina aurella*, *Lecanora muralis*, and *Rhizocarpon* spp. on rough stone. Those with a small thallus

are easily ousted by the more massive species, such as *Lecanora sordida* and *Pertusaria lactea*: the thick thallus overruns the thinner specimens. After the crustaceous there arrive the foliaceous forms, which destroy the former by covering them. But these large lichens are generally short-lived; they die out, and the bare place becomes again colonized as before. A. L. S.

River Lichen.—C. F. E. Erichsen ("*Staurothele catalepta* (Ach. Zschacke nov. var. *fluviatilis* Erichs. eine charakterflechte des Tidengebiets der Unterelbe," *Festschrift Bot. Ver. Hamburg*, 1891–1931, 1931, 24–33, 2 figs., 1 map). Erichsen found this mountain lichen on the riverside near the mouth of the Elbe both above and below Hamburg. It attracted his interest and attention as the unusual case of a lichen found on mountain rocks growing between tide levels. It grew in some places subject to tides so densely as to form a *Staurothele fluviatilis* association; in other places it was associated at higher levels and with other lichens. One point he specially noted was its absence at a certain part of the river that suffered from the inflow of deleterious matter from the town of Hamburg. He argues that as land lichens are easily driven out by soot and other contamination, so *Staurothele* shares the sensitiveness of the lichen to water pollution. Another interesting point was that it grew most luxuriantly where there was an alternation of wet and dry conditions. A. L. S.

Classification of Gelatinous Lichens.—A. A. Elenkin and M. M. Hollerbach ("Sur la place qu'occupe *Leptogium Issatchenkoi* Elenk. dans le système des lichens gelatineux, rattachée à la question de l'importance des variations individuelles (réversibles) et héréditaires (irréversibles)," *Journ. Soc. Bot. Russie*, 1930, **15**, 241–80, Russian with French *résumé*). Elenkin calls for a renewed classification of gelatinous lichens based on hereditary fixed characters. He quotes Hollerbach on *Collema Ramenskii*, who found that the growth of cortex and rhizinæ was induced by specific influences such as the presence of bacteria or the close association of the lobules. He cites cases in which new species have been established on accidental variations: thus he condemns Rassadina's new species, *Umbilicaria pertusa*, as merely a degenerate form of *U. pennsylvanica* Hoffm., in which the pustules in unfavourable conditions have dropped away, leaving holes. Other similar instances are adduced to confirm his views. He considers that *Cladonia rangiferina* and *Lecanora subfusca* correspond to "linneons," their associated species to "jordanons." He would also discard species based entirely on chemical reactions. A. L. S.

Systems of Classification.—A. A. Elenkin ("Sur les relations réciproques des systèmes généalogique et combinatif basées sur la classification des lichens," *Journ. Soc. Bot. Russie*, 1929, **14**, 233–54, 4 figs., Russian with French *résumé*). Elenkin presents two systems of classification: the "genealogical," based on the divergence of characters, and the "combinatif," on their convergence. These two principles occur in nature in the formation of species, but the former, the genealogical, on which Darwin founds his "Origin of Species," is much the more frequent; the combinatif, according to him, is only a particular modification of the genealogical. He illustrates the theme by tables, with vertical and horizontal lines, which represent his conception of the development of species in space and time. A. L. S.

Lichen Classification.—A. A. Elenkin ("Le système combinatif de lichens basé sur les faits de leurs relations phylogéniques," *Journ. Soc. Bot. Russie*, 1929, **14**, 133–64, 4 tables). Elenkin's system is based largely on the form and structure

of the thallus; the types of fructification are largely independent. The thallus is more purely a lichen formation. The author has combined these two distinguishing characters in tables which he explains. The results do not differ materially from the general conception of lichen classification. A. L. S.

Study of Solenopsora.—H. Choisy and R. G. Werner ("*Solenopsora Montagnei* (E. Fr.) Choisy et R. G. Werner nov. comb. et le genre *Solenopsora* (Massal.) emend.," *Bull. Soc. Hist. Nat. Afr. Nord.*, 1931, **22**, 7–12, 1 text-fig.). The authors have concluded, from their study of this species, that the place of *Solenopsora* as a lecanorine genus near to *Lecania* is untenable. They place it, rather, among the Physciaceae near to *Rinodina*. They deprecate a too slavish use of spore characters in classification. A. L. S.

Lichens of Athabasca.—Lucy C. Raup ("The Lichen Flora of the Shelter Point Region, Athabasca Lake," *Bryologist*, 1930, **33**, 57–66, 4 pls.). This description of the lichen flora centres on the north-west shore of Lake Athabasca. Many specimens were collected, and about 80 species were determined. The present account concerns their ecology and distribution; the districts comprised are the stony and sandy shores of the lake, the steep cliffs of granitic rock, and the rocky upland (also granitic) with a scrubby covering of *Pinus, Betula, Vaccinium*, etc. The writer goes on to describe the various lichen associations of the district—a *Verrucaria* association down to and below the water-level consisting of *V. nigrescens*. Higher up *Dermatocarpon miniatum* is combined with the *Verrucaria*, and beyond that a *Rhizocarpon* (*Rh. geminatum*)—*Physcia* (*Ph. cæsia*)—*Lecanora* (*L. cinerea*) association. Other secondary species are included and listed. The rocky upland is dominated by *Parmelia saxatilis* and *Gyrophora Muhlenbergii*. The terricolous regions include a *Cladonia-Cetraria* association, while on the trees there is a *Parmelia Evernia* association. The ground flora of the Muskeg has for primary species *Peltigera aphthosa*, and, as secondary, *Lecidea granulosa* and various *Cladoniæ*, with *Icmadophila æruginosa*. A. L. S.

Cetraria islandica.—Fran Kusau (Bot. Inst. Zagreb)—("*Lichen islandicus* (*Cetraria islandica* Ach. u Jugoslaviji)," *Vjesnika Ljckarnika*, 1930, **12**, 1–8, 3 text-figs., Croat with German *résumé*). A short morphological and anatomical description of this lichen is given, followed by an account of its geographical distribution. Kusan finds that it flourishes under the same conditions in Jugoslavia as in the Carpathians and the Alps, and is to be found mainly in high mountains on wind-exposed situations free from snow, and always in similar associations. A. L. S.

Lichens of Jugoslavia.—Fran Kusau ("Lisaji-Die Flechten Insel Dugi," *Prirodoslovna istrazivanja*, 1930, **16**, 159–62). Kusau follows up the work already done by A. Zahlbruckner in his lichens of Dalmatia. She records 42 forms, a considerable number of which are new to the island (Dugi). They were collected by Prof. J. Pevalek. A. L. S.

New Lichens from Dalmatia.—Fran Kusau ("Neue Beiträge zur Flechtenflora des kroatischen und dalmatischen Kustenlandes," *Acta Botanica Inst. Bot. Univ. Zagreb.*, 1930, **5**, 18–47, 1 text-fig.). Much work on the lichens of Dalmatia was done in former years by A. Zahlbruckner in a series of papers. He had considered the country as including three lichen zones: a northern Istria-Dalmatic zone, a southern Adriatic zone, and a third which included the more inland places.

It was not considered that floristically the lichens tallied with the higher plants of northern and southern characters. But more research seems to indicate that there are distinctive floras for north and south. Fran Kusau has examined the various lists and has grouped the representative lichens of the different regions. She finds that in the south there is a much more distinctive flora than in the north (the Istria zone), while further inland she notes resemblance to the lichens of Illyria. A systematic list of lichens is given for two of the islands, Hvar and Pag. A. L. S.

Russian Lichens.—K. Rassadina ("Les lichens recueillis par S. Ganešin dans le district de Luga et dans les environs de Novo. Sieverskaja, gouvernement de Lenigrad," *Acad. Sci. U.R.S.S.*, 1930, **22**, Russian with German *résumé*). The paper deals with 70 lichen species, a number of them of great interest in distribution. Two new varieties in the genus *Peltigera* are recorded. *Peltigera horizontalis* is listed as an arctoalpine species rare to Russia. Several Collemaceæ are recorded also as rare. A. L. S.

Lichens in Ecological Associations.—Hugo Bojko ("Der Wald im Langenthal (Val Lungo). Eine pflanzensoziologische Studie aus den Dolomiten," *Bot. Jahrb. für Syst. Pflanzenges. und Pflanzengeogr.*, 1931, **64**, 48–144, 3 pls.). The author discusses the floristic relationships of these Dolomite woods with the surrounding countries, and also the physical nature of the country, climate, etc. A few lichens are recorded as forming part of the *Picetum*, the *Pinetum cembræ* and the *Laricetum* associations. Only a few species are recorded. A. L. S.

Recent Lichen Literature.—A. Lorrain Smith (*Brit. Mycol. Soc. Trans.*, 1931, **15**, 193–235). The paper begins with a record of the work of three distinguished lichenologists lately deceased: Wainio of Finland and Bruce Fink and G. K. Merril of America. The writer proceeds to record the various lichen publications that have appeared in recent years. Important work has been done on every aspect of lichenology, and the results are indicated. Many of the papers cited deal with Ecology and Distribution. Students of lichens have much work to do in discovering and recording lichen plants in all quarters of the globe. A list of publications of the last few years is appended. A. L. S.

Epiphytic Vegetation.—Liou Tchen-ngo ("La Végétation epiphytique des bois de Conifères," *Bull. Soc. Bot., France*, 1929, **76**, 21–30). The author is principally concerned with lichens in this paper; other types of plants are epiphytic on conifers, but they are more or less fortuitous. He lists a considerable number, several of which are only occasional. The lichen population of the pines—chiefly *Pinus sylvestris*—scarcely begins until the clearance of ground growth. Then arrives a crustaceous stage of several *Lecanoræ*, *Parmelia exasperata*, etc. This phase is only of short duration, and is succeeded by foliaceous species, mainly *Parmelia physodes*. Later *Evernia furfuracea* become prominent, and finally fruticose forms such as *Usnea barbata* and *Alectoria jubata*. Notes are given on the altitude of the territory and the orientation of the trunks. Lichens grew more freely on the sides exposed to rain, and also on the upper reaches of the trees. It is also stated that trees in an unhealthy or backward condition were more covered than healthy trees, and the writer has also concluded that the covering of lichens, though entirely saprophytic, tends to a certain degree to retard assimilation and respiration, thus accelerating the death of already enfeebled trees. Another association—*Physcia pulverulenta*, *Parmelia scortea* and *Ramalina fraxinea*—developed on isolated trees in the valleys. A. L. S.

Lichen Dispersal.—G. Einar Du Rietz ("Studier över vinddriften på snöfält i de skandinaviska fjällen," *Bot. Not.*, 1931, 31–44). Du Rietz considers the question of the dispersal of plants inhabiting snowfields, termed Chionochorous plants. Lichens as rock plants bulk largely in the inquiry. There are two types of these "chionochorous" plant dispersals: (1) lichens on alpine habitats where there is little or no snow (chionophobous lichens), and lichens on habitats that are covered with snow except in summer. The "chionophobous" lichens on the wind-swept rocks are the more numerous, and the number of lichens in the wind-drift of the snow-fields would largely belong to that group. A. L. S.

Lichen Development.—R.-G. Werner ("Sur la Formation des Lichens," *Compt. rendus Acad. Sci.*, 1930, **191**, 1361–2). Werner has studied the association of lichen fungus and gonidia in nature. He found the moist surfaces of the Agave inhabited by the early stages of lichen growth, and he followed out a research on the early development of *Xanthoria parietina* by making hand sections of the bark. On germination the hyphæ from the lichen spore travel in search of the gonidia, which are generally heaped in the stomatal depressions. The hyphæ encircle the algæ, and these increase in size and divide. In a second phase, hyphal branches penetrate among and separate the newly forming gonidia. Other longer hyphæ search for more algæ. Gradually a cortical layer is formed, while the lower hyphæ attach themselves to the support. Growth of the lichen increases, the gonidial layer is established, as also the medulla and the lower cortex with its rhizoidal penetrating filaments. Further expansion of the young lichen takes place by the hyphæ pushing the gonidia towards the edges, and the rounded mass becomes a spreading leaflet. Werner has concluded that the form of the thallus is determined by the fungus, and that the algal influence is secondary. A. L. S.

Lichen Galls.—E. Bachmann ("Die Gallen zweier Laubflechten," *Arch. Protistenk.*, 1930, **71**, 323–60, 34 text-figs.). Bachmann reviews work previously published by him on the galls of *Parmelia physodes*. He now describes two different types, *Physodes* A and *Physodes* B. In both, after infection by a fungus, there is a marked development in the number of gonidia, and these, along with the intruding hyphæ, give a dark appearance to the surface of the gall. Finally tangential gall hyphæ spread in the gonidial zone and form asci; these pass into the cortex and contain eight ellipsoid spores. At the point of escape the cortical hyphæ are absorbed; other gall hyphæ form a pseudo-hymenium. No gall hyphæ reach the medulla, but the lichen hyphæ increase and fill the space beneath the swollen gall. In *Physodes* B galls the development is also carefully worked out. In these there is a more advanced type of apothecium formed with a margin formed of gall cells: this latter he terms "protapothecia." Pycnidia also take part in the formation. In a further study (p. 352) he describes pseudo-galls in *Peltigera* sp. Their development begins with increase of gonidia. They reach a considerable size and become dark in colour, for which reason he considers they cannot serve as enlarging the assimilation tissue. They are not caused by any disturbance due to fungi or insects, and the tissues formed differ from the true galls. A. L. S.

Parasymbiosis.—R. G. Werner ("Nouvelle contribution à la Flore cryptogamique de l'Alsace. La Parasymbiose," *Bull. Ass. Philomath. Alsace et Lorraine*, 1928–29, **7**, 245–57, 1 text-fig.). The author recapitulates the views held by various workers on "lichen parasites," which are very numerous, and in many cases the association is symbiotic rather than parasitic: the hyphæ of the parasite pierce the lichen tissue and associate as symbionts with gonidia of the host.

Werner gives new instances of this association or parasymbiosis. He finds three different conditions in the association: (1) parasymbiosis at the beginning, then a tendency towards saprophytism by the fungus, with destruction of the host, followed by the establishment of the parasymbiont on the bark as a saprophyte; (2) obligatory parasymbiosis, the fungus adopting the gonidia and often forming galls; (3) obligatory parasymbiosis without injury to the lichen, the gonidia forming galls. There seems no evidence that the parasymbiotic organisms eventually become independent lichens. A. L. S.

Mycetozoa.

Malayan Myxomycetes.—YOSHIKADZU EMOTO (*Journ. Bot.*, 1931, **69**, 38–42). The mycetozoa here enumerated were collected at various places in Singapore and the Malay Peninsula. They grew on fallen leaves, rotten wood, etc. The species collected number 43, three of them new records for the district. A. L. S.

Notes on Malayan Mycetozoa.—G. LISTER (*tom. cit.*, 42–3). G. Lister gives us notes that were made in Malay by A. R. Sanderson and sent to her. They refer to the growth and appearance of rare species. Thus under *Alwisia bomarda* Berk. & Br. it is recorded that large colonies appeared "near my bungalow at Petalang." Hundreds of immature sporangia were eaten by insects, but many developed perfectly. There follows a description of the colour and development of the sporangia. A. L. S.

Rare Mycetozoon.—G. LISTER ("On the Occurrence of *Licea pusilla* (Schrader) in Essex," *The Essex Naturalist*, 1931, **23**, 61–3, 1 pl.). This mycetozoon appeared on an oak log brought in doors and watched for the development of various species, such as *Arcyria pomiformis*, *Comatricha nigra*, etc. In about a week's time the minute sporangia of *Licea pusilla* were observed: the sporangia were numerous; they measured 0·1 to 0·3 mm. diameter. The somewhat peculiar ridges on the sporangia are described, as well as the spores. Sporangia and spores are figured on the plate. A. L. S.

Study of Didymium.—F. X. SKUPIENSKI ("Sur la coloration vitale de *Didymium nigripes* (Fr.). Note préliminaire," *Acta Soc. Bot. Pol.*, 1929, 201–13, 1 pl.). The author has cultivated the mycetozoon *Didymium nigripes* from the spore onwards in a medium containing neutral red, methylene blue, and other colour reagents. It is with the red and the blue he is chiefly concerned. In the colour-charged media the spores germinated, small plasmodia were formed, and the accompanying bacteria developed normally. Skupienski was thus able to follow clearly all the stages of growth and to note where the colour was more or less intense and continuous. He also tested the cultures with a mixture of the two colours. The plasmodia and sporangia were deeply coloured, also the spores. The sporangia, however, became finally a grey colour, owing to a covering of lime. When the spores were resown, they germinated normally and without colouration. It was thus possible, by these colours, to detect points of difference in the living organism not otherwise clearly visible, and without injury. Other colours reacted somewhat differently. Janus Green B is usually considered to colour chondrosomes, but none responded to the test. A. L. S.

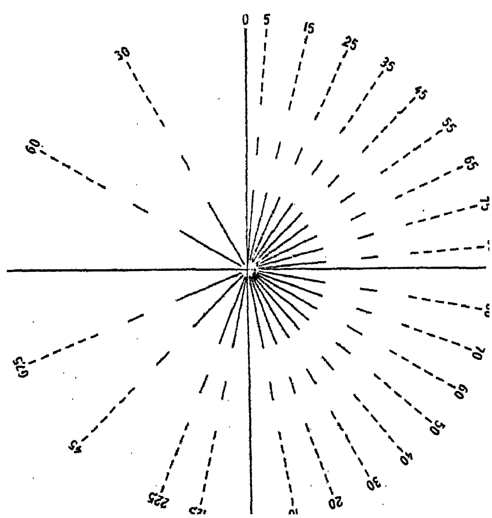
Further Study of Didymium.—F. X. SKUPIENSKI ("Influence de la température sur la fructification de *Didymium nigripes* (Fr.)," *Acta Soc. Bot. Pol.*, 1930, **7**, 241–9, 3 text-figs.). The author points out the influence of external

circumstances—especially of temperature—on the development of myxomycetes. He grew the *Didymium* in normal cultures and then at enhanced temperatures, and he records the changes that took place in the size of the sporangia, the colour and appearance of the stalks, the presence and absence of lime crystals, and, in internal characters, the appearance of vesicles on the hyphæ, and in the size and form of the spores. The author argues, from the changes noted by him in cultures from similar spores, that there is no doubt as to the correct determination of the species. A. L. S.

TECHNICAL MICROSCOPY.

A New Angular Eyepiece Micrometer.—This micrometer, made by Messrs. Carl Zeiss, Jena, to the design and specification of Mr. W. Faitoute Munn, F.R.M.S., of New York, and devised by him for the purpose of measuring the angles of various known and unknown microscopic crystals, and for determining the angles of various dotted and line structures in diatoms, is a useful accessory, and should prove of interest and utility to microscopists.

The glass disc with the angular scale engraved thereon fits into the Zeiss × 6 compensating ocular in the same manner as the ordinary eyepiece micrometer scale, and has been called by Mr. Munn the angular eyepiece micrometer.



An enlarged photograph of the engraving is shown herewith, which requires no further description.

All one needs to do to measure the angle of a crystal is to focus the object and then, by rotating it and manipulating a mechanical stage, bring the angle to be measured into the centre of the field until the desired angle coincides with the matching scale of the micrometer. Although all angles are not marked on the micrometer, there are sufficient present, so that if the exact angle is not found there will be one or more slightly greater or less than the desired one, so that the true angle of the unknown can be quite accurately calculated.

Contribution to the Chemistry of the Plant Cell Wall. V. Microscopy of Acid-Treated Sawdust as an Index to Some of the Differences in Physical Properties of Hardwood and Softwood Lignin.—W. M. Harlow (*Ind. Eng. Chem.*, 1931, **23**, 419–21). When sawdust is treated with 75 p.c. sulphuric acid to remove the polysaccharides, and the solution diluted, softwood lignin separates out quickly, the liquid is easily filtered, and the dried lignin is of a porous nature. With hardwood, settling of the liquor is slower, the solution more difficult to filter, and the residual dried lignin is in the nature of a hard brittle cake. These differences are associated with the microchemistry of the cell wall. A microscopical examination of the lignin shows that it consists, in the case of softwoods, of the middle lamella or central layer, while in hardwood lignin, swollen and partially disintegrated, secondary layers are also present. Incomplete removal of cellulose is not the cause of any differences in the character of the lignin. Hardwoods and softwoods may be differentiated by their reaction towards hydrolysis by 75 p.c. sulphuric acid. Microphotographs are given. A. H.

A Microscopic Study of the Effects of Cold Temperatures upon Skins and Hides.—F. O'Flaherty and W. T. Roddy (*Journ. Amer. Leather Chem. Assoc.*, 1931, **26**, 172–80). The authors show that the structure of hides and skins is not adversely affected as the result of freezing to as low a temperature as − 10° C. for several weeks. The frozen skin soaks back normally in water, provided it is first brought to the temperature of the water by exposure to air before immersion. Liming also proceeds satisfactorily. The paper is illustrated by 17 microphotographs. A. H.

The Analytical Microscopy of Commercial Egg Albumin.—S. Mendelsohn (*Chemist-Analyst*, 1931, **20**, 4). Coagulated residues in commercial egg albumin can be readily detected by examining a sample in clove oil under the microscope, when such impurities are shown up as red, yellow or brownish particles. A. H.

Some Notes on Microscopic Technique, with Special Reference to Micro-tannology.—F. O'Flaherty (*J. Amer. Leather Chem. Assoc.*, 1931, **26**, 257–63). Modifications of standard technique to meet the requirements of the leather technologist are described. Where fixing of specimens of pelt or leather is necessary, 24 hours' immersion in 5–10 p.c. formalin at ordinary temperature is recommended. Heating is undesirable. Embedding in celloidin is unsatisfactory, while the paraffin method, although tedious, can be used. The best method is by freezing. For demonstrating lipins in skin, the section is stained with nile blue sulphate and then dipped into 10 p.c. acetic acid, when the skin will appear light blue, soaps blue, and true fats red. Elastin is demonstrated by Weigert's elastin stain, pre-treating the specimen with dilute sodium carbonate or bicarbonate. Reticular tissue can be shown up by staining the fixed and cut section with iodine and placing the slide in a warm place to dry. The reticular tissue can then be seen as a fine network. Full details for preparing all reagents are given. A. H.

Studies in the Physiology of Moulds. II. The Chemical Composition and Culture of Moulds.—G. E. Rockwell and F. O'Flaherty (*J. Amer. Leather Chem. Assoc.*, 1931, **26**, 216–22). *Aspergillus niger* was cultivated for 17 days on Czapek's medium, washed, air-dried for an hour, and analysed:—Water 84·62 p.c., salts (ash) 0·64 p.c., proteins (N × 6·25) 3·47 p.c., carbohydrates (as dextrose) 6·24 p.c., fat (ether extract) 0·58 p.c., undetermined 4·45 p.c. The

ash contained chlorides, phosphates, carbonates and sulphates of magnesium, calcium, sodium potassium and iron. *A. nidulans* has higher moisture, ash and nitrogen contents, while *Penicillium* has a higher fat and a lower ash content. As compared with *Aspergilli*, the *Mucoraceæ* are higher in moisture, nitrogen and fat, but lower in ash. A modified Czapek's medium, which hinders bacterial growth, and is very suitable for routine work, is as follows:—Dextrose 20 parts, ammonium sulphate 2 parts, dibasic potassium phosphate 1 part, potassium chloride 0·75 part, magnesium sulphate 0·50 part, ferrous sulphate 0·01 part, water 1,000 parts. When sterilized, this medium will have a *p*H of 6·4–6·6. It can be raised, if desired, to *p*H 5·0 by adding 3–4 c.cs. of N.HCl. per litre. When a solid medium is required, 15–20 gms. of agar per litre are added. A. H.

NOTICES OF NEW BOOKS.

Handbook of Chemical Microscopy.—By E. M. Chamot, B.Sc., Ph.D., and C. W. Mason, A.B., Ph.D. Vol. I, 1930. Principles and Use of Microscopes and Accessories; Physical Methods for the Study of Chemical Problems. xiii + 474 pp., 162 figs. Vol. II, 1931.—Chemical Methods and Inorganic Qualitative Analysis. ix + 411 pp., 181 figs. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2. Price 22*s*. 6*d*. net each vol.

Chemical microscopy is defined by the authors as the use of the microscope in the solution of chemical problems in contradistinction to microchemistry, which merely implies chemistry on a microscopic scale. Since the number of problems susceptible of solution by microscopical methods is already enormous and is continually growing, there is ample room for a work of this kind. In a short notice such as this it is absolutely impossible even to mention the many subjects discussed, each with an insight and practical experience which can only be compared with an analogous work, "The Microtomist's Vade-Mecum." All that can be said is that in the first volume there is little in regard to the use of the microscope which is neglected, even the technique of such a comparatively new branch as photomicrographic cinematography receiving adequate notice. In the second volume an account is given of more strictly chemical methods of detecting the varying anions and cations under the microscope. In addition, the volumes form a valuable work of reference to original papers, many of them, it is pleasant to note, published in the pages of this Journal. The work is one which should find a place in the library of every scientific laboratory. G. M. F.

The Science of Life.—By H. G. Wells, Julian Huxley, and G. P. Wells. xvi + 896 pp., 339 text-figs. Published by Cassell & Co., Ltd., London. Price 21*s*. net.

The versatility of Mr. H. G. Wells is such that, with pleasant memories of "The Outline of History," one turns with feelings of expectation to this new opus on the science of life. The whole scope of life in its origin, development, mutations and variations is here said to find careful and lucid explanation: from the earliest to the latest of living creatures of earth and sky and sea: from the tiniest ultra-microscopic fragment of life to the greatest of the earth's denizens. The task is

an ambitious one, and admiration cannot be withheld from the labour and energy which must have been expended in marshalling so many facts and rival theories. Nevertheless, the question arises as to whether the detail is not too great for the man in the street or for Mr. Everyman, as the authors prefer to call him, while for the professional scientist who wishes to gain some knowledge of other branches than his own the treatment is too popular. Nor are the facts always quite accurate: calomel has many uses, but it can hardly be regarded as an ordinary antiseptic! Many of the illustrations are poor, and would be improved by the addition of some scale of measurement. With more careful editing, "The Science of Life" should, in future editions, take its place as a worthy compeer of "The Outline of History."

G. M. F.

Researches on Fungi.—By A. H. Reginald Buller, D.Sc., Ph.D., F.R.S. Vol. IV, 1931.—Further Observations on the Coprini, together with Some Investigations on Social Organization and Sex in the Hymenomycetes. xiii + 329 pp., 4 pls., 149 illustrations. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 21*s*. net.

Faune de France: Mollusques terrestres et fluviatiles (première partie). —By Louis Germain. Paris: Lechevalier. 454 pp., 13 pls., 470 figs. 150 fr. The second part, including the index, is announced to appear shortly.

The author has evidently experienced the same difficulties as ourselves in getting hold of the numerous scattered publications in which the "malacology" of the last half century is enshrined. Indeed, we found once that the actual cost of the papers, *if obtainable*, would amount to something like £300; and, after a taste of their quality, we decided to refrain from the search, since they contain little or no malacology, and most of the descriptions of shells were almost meaningless. This is very near to saying that we shut up the book of French malacology with Moquin-Tandon to reopen it with Germain; we have therefore missed the lucubrations of some eighty years. But it does not seem probable that many of those described species which M. Germain has "placed in the synonymy" are worthy of any better fate. If anyone in the future should take up the detailed study of this mass of ill-conceived nomenclature, it is to be hoped that he will make it the base of a proposal to the International Congress to rescind or drastically amend the laws at present governing nomenclature. As to classification, we do not think it is progressive to place the Arions next to the Limaces; a single record of *G. maculosus* in 1868 gives it very little right to a place in the French list, especially as the locality does not seem plausible; *Limax arborum* is well distinguished from all other slugs by its radula, and so also are probably all other species of slugs which are not merely slight racial variations. Before the genitalia of any of these animals can be satisfactorily described, we need to find a practical method of preserving them, and also to make a large number of experiments to ascertain what changes they undergo in each species during the lifetime of the animal. This alone might occupy some skilful manipulator for ten years or more; at the same time he should make histological preparations of the different parts, and be prepared to go over all his work several times if it should prove that any detail in the *process* is unsatisfactory. Examination of the radula of *Testacella scutulum* will at once relieve anyone of the lingering suspicion that it is only a variety of *T. haliotidea* Drap. In this genus also we find several semi-mythical species retained. If the bodies of these are still preserved in the Paris Museum or elsewhere, good preparations of the

radula can still be made, though the rest of the internal organs will be useless. We recommend the same investigations in the case of the genus Vitrina. In this genus we have three or four species in these islands, of which one is common and the others rare or local. Of the common one I have examined about 200 radulæ without finding any considerable degree of variation; the others are quite distinct when found. The best way to get a picture of the radula is to remove the muscular sac entire and boil it in weak caustic potash or soda, after which it is spread out entire on a clean slide, and the caustic removed by successive washings. It will adhere to the slide when dry, and can then be photographed by direct illumination, using an apochromatic objective of N.A. 0·65, corrected for use without a cover-glass. (No detail here mentioned is superfluous.) In the Zonitids and their allies we think that a study of the radula would convince readers that the number of species recognized can be materially reduced. We are glad to see that the anatomy of *Leucochroa candidissima* is done justice to, and the account of the Helicidæ is very excellent. With this book in our hands we are in a position to take up the scientific study of the snails of Western Europe. The author is a worthy successor of Moquin-Tandon, and we do not think that higher praise could be given to any malacologist.

E. W. B.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, B.M.A. HOUSE, TAVISTOCK SQUARE, LONDON, W.C.1, ON WEDNESDAY, MARCH 18TH, 1931, AT 5.30 P.M., MR. J. E. BARNARD, F.R.S., F.INST.P., IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the Chairman.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

Dheenath Sitanath Ajinkya, Bombay.
Abel Prescott Bradshaw, Manchester.
John Clegg, Southport.
Pieter Cornelis Jansen, The Hague.

The Nomination Certificates in favour of the following candidates were read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

Charles H. Bartlett, Luton.
Lawrence Turner Fairhall, M.A., Ph.D., Newton, Mass.
Edwin Ernest Jelley, Harrow.
John William Laden, London.
Sydney Linfoot, Harrogate.

Deaths were reported of :—

J. S. Dunkerley. Elected 1921.
F. W. Harris. Elected 1928.
R. R. Whitehead. Elected 1886.

Votes of condolence with the relatives were passed.

Donations were reported from :—

Messrs. Cassell & Co., Ltd.—
"The Science of Life." By H. G. Wells, Julian Huxley, and G. P. Wells.

Royal Dublin Society—
"Bi-Centenary Souvenir, 1731–1931."

Mr. J. Richardson, F.R.M.S.—
Micro Slide of *Amphipleura pellucida* with *Epithemia* mounted in Hyrax.

Votes of thanks were accorded to the donors.

Balance-Sheet.—The Chairman called upon the Treasurer, Mr. C. F. Hill, who presented his Financial Report and Balance-Sheet for the year 1930.

FINANCIAL REPORT FOR THE YEAR ENDED 31st DECEMBER, 1930.

The past year has been one of considerable difficulty and anxiety incidental to the problem of finding and negotiating for suitable new quarters for the Society's offices, meeting rooms, library, instruments, etc., and a great strain has fallen upon the Secretaries.

The Accounts show a balance of Expenditure over Income of £161 17*s.* 2*d.*, which, added to the balance of £88 1*s.* 7*d.* brought forward from the previous year, makes an accumulated debit on this account of £249 18*s.* 9*d.*

Three Fellowship Subscriptions have been compounded, and the Life Membership Account now stands at £1,979.

In accordance with Council's standing order No. 6, £200 has been invested on Capital Account, making, with the balance brought forward, a total of £2,176 1*s.* 5*d.* on account of investments, the market value of which at 31st December, 1930, was £2,335 10*s.* 5*d.*

The Loan Account due to the Treasurer has been further reduced by a donation of £50, leaving £250 outstanding on this account.

On account of the Library the sum of £160 1*s.* has been expended, but this has been offset by a grant of £150 from the Trustees of the Carnegie United Kingdom Trust, which was ably negotiated by the Librarian, and I am certain that the Library, in its new home, and with the greatly increased facility for reference, will prove worthy of the Society and of increasing usefulness and importance.

Consequent upon the removal of the Society to its new quarters, certain new furnishings and equipment had to be acquired, and other derelict and unsuitable effects replaced. Partial provision was made for this last year, when a sum of £50 was set aside on this account.

It should be noted, too, that the whole of the expenses consequent upon removal and the replacement of derelict furniture and equipment have been met out of income, and without drawing upon the Society's invested funds.

It should further be noted that, until the termination of the Society's lease of premises at Hanover Square, the Society is incurring an additional liability of approximately £200 on account of rent and accrued dilapidations.

With regard to the Journal, the cost in the year under review has considerably increased, but I venture to think that everyone will agree that the publication of original researches and the extensive series of abstracts is one of the Society's most valued and important functions, and that this increased expenditure has been justified. It is pleasing to record that the sales have been well maintained, and that a grant of £200 has been received from the Royal Society.

On the Income side of the Accounts sundry receipts and donations, I am happy

to report, show a welcome increase on the preceding year; and while Admission Fees are the same amount as last year, it will be noted that Subscriptions are down by £15. The Membership figures show a decrease, and this fact is brought to the earnest consideration of the Fellows.

Finally, I should like to express my personal thanks and appreciation to the Honorary Auditors, Messrs. Thomson McLintock & Co., for their valued services to the Society during the year, and to pay my tribute to the Secretaries for the signal services they have rendered to the Society during the difficult period of removal, and especially to Dr. Tierney for his able conduct of the negotiations in connection therewith, and excellent management of the Society's affairs.

The number of Fellows on the Roll of the Society at 31st December, 1930, is as follows :—

Number of Fellows on the Roll at 31st December, 1929			504	
Fellows elected or reinstated during year			24	
Fellows resigned or removed during year		21	528	
Fellows deceased during year		14		
			35	
			493	
The total is made up of :—				
(a) Ordinary Fellows		451		
of whom * 414 have paid current subscription				
27 are one year in arrear				
10 are two years in arrear				
451				
(b) Life Fellows		30		
(c) Honorary Fellows				
Number on Roll at 31st December, 1929	15			
Elected during year	1			
	16			
Deceased during year	4			
		12		
				493

* In addition 8 Fellows paid their current year's subscription previous to death or resignation.

For Balance Sheet *see* pp. 214, 215.

On the motion of Mr. C. F. Hill, seconded by Mr. J. Wilson, the Report and Accounts were unanimously approved and adopted.

The Chairman moved the following resolution, which was carried :—

"That the best thanks and appreciation of the Fellows be conveyed to the Society's Honorary Auditors, Messrs. Thomson McLintock & Co., for their valued services to the Society during the past year."

Dr. INCOME AND EXPENDITURE ACCOUNT

1929. £ s. d.		£ s. d.	£ s. d.	£ s. d.
185 7 3	To Rent, Lighting, Heating and Insurance .			275 8 0
447 14 6	,, Salaries, Reporting, etc. . . .			450 8 0
	,, Sundry Expenses—	£ s. d.		
	Library Books and Binding	160 1 0		
	Less: Grant in respect thereof	150 0 0		
			10 1 0	
	Stationery, Printing, Postages and Sundry Expenses		142 3 4	
	Repairs and Renewals		53 16 1	
178 17 6	Refreshments at Meetings . .		6 15 0	
	,, Journal, etc.—			212 15 5
	Expenditure—			
	Printing		890 12 10	
	Editing and Abstracting . .		85 3 6	
	Illustrating		150 1 8	
	Postages and Addressing . .		66 3 6	
	Less Receipts—	£ s. d.		
	Grant from Royal Society	200 0 0	1192 1 6	
	Sales	561 9 8		
	Advertisements . .	55 10 8		
			817 0 4	
181 19 6				375 1 2
49 16 8	,, Depreciation of Furniture			— — —
14 2 2	,, Balance, being Excess of Income over Expenditure for year to date . . .			— — —
£1057 17 7				£1313 12 7

Dr. BALANCE SHEET AS AT

Liabilities.	£ s. d.	£ s. d.
I. *Capital*—		
Being (*a*) Life Compounded Subscriptions received from 1st January, 1877, to 31st December, 1930	1979 0 0	
(*b*) Quekett Memorial Fund	100 0 0	
(*c*) Mortimer Bequest	45 0 0	
(*d*) A. N. Disney Bequest	100 0 0	
(*e*) Amounts received in respect of Sales of Books from the Library (surplus to the Society's requirements)	253 12 0	
		2477 12 0
II. *Loan Account*		250 0 0
Note.—The Hon. Treasurer of the Society has advanced this sum to meet the cost of publishing "The Microscope and Catalogue of Instruments." The loan is made to the Society free of interest.		
III. *Sundry Creditors*—		
Subscriptions paid in advance	28 6 8	
Journal Subscriptions paid in advance	114 18 0	
On account of Journal Printing, etc.	459 8 10	
		602 13 6
		£3330 5 6

London, *16th February*, 1931. We have examined the Books and Accounts of the Royal Microscopical Society for the year to 31st December, 1930, and have found the transactions correctly recorded and sufficiently vouched.

In our opinion the foregoing Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Society's affairs, subject to it being noted that

FOR YEAR TO 31st DECEMBER, 1930. Cr.

1929. £	s.	d.		£	s.	d.	£	s.	d.
			By Subscriptions	815	0	1			
880	16	11	„ Subscriptions for 1930 unpaid	50	18	6			
							865	18	7
13	12	0	„ Donations and Sundry Receipts				118	8	5
58	16	0	„ Admission Fees				58	16	0
104	12	8	„ Interest on Investments and Deposit Account				108	12	5
–	–	–	„ Balance, being Excess of Expenditure over Income for year to date				161	17	2
£1057	17	7					£1313	12	7

31st DECEMBER, 1930. Cr.

Assets.	£	s.	d.	£	s.	d.
I. *Furniture and Equipment* as at 31st December, 1929	200	0	0			
Additions during year	38	11	10			
	238	11	10			
Less: Sales during year	15	10	0			
				223	1	10
II. *Investments at Cost*				2176	1	5
£400 London & North Eastern Railway Co. 3% Debenture Stock.						
£500 Nottingham Corporation 3% Irredeemable Debenture Stock.						
£915 11*s*. 4*d*. India 3% Debenture Stock.						
£150 Metropolitan Water Board "B" Stock.						
£612 London Midland & Scottish 4% Preference Stock.						
£200 New South Wales 5½% Loan 1947–57.						
£421 1*s*. 5% War Loan, 1929–47.						
£200 5% Conversion Loan 1944–64.						
Note.—The Market Valuation of the above Investments at 31st December, 1930, was £2,335 10*s*. 5*d*.						
III. "*The Microscope and Catalogue of Instruments*"—Amount expended on publication to date, less sales in previous years	293	15	3			
Less Sales for 1930	45	4	4			
Note.—The Hon. Treasurer of the Society has given his personal guarantee to meet any part of this expenditure that is not recovered by means of sales of the publication.				248	10	11
IV. *Sundry Debtors*—						
Subscriptions unpaid, amounts due in respect of Journal Sales, Advertisements, etc.				158	17	7
V. *Cash at Bank*—						
On Deposit Account	100	0	0			
On Current Account	173	15	0			
				273	15	0
VI. *Income and Expenditure Account*—						
Balance as at 31st December, 1929	88	1	7			
Add: Excess of Expenditure over Income for year to date	161	17	2			
				249	18	9
				£3330	5	6

no account has been taken of the value of the Society's Library, Stock of Journals, and Collection of Instruments (valued for insurance, together with the Furniture and Equipment, at £4,600).

(Signed) THOMSON McLINTOCK & CO.,

71, *Queen Street, E.C.* 4. *Chartered Accountants, Hon. Auditors.*

Exhibits.—Mr. Conrad Beck, C.B.E., exhibited and described a new microscope slow motion fine adjustment and mechanical stage.

Mr. B. K. Johnson exhibited and described some ultra-violet photomicrographs of diatoms and metal specimens.

In expressing the thanks of the Fellows to the exhibitors, the Chairman complimented Mr. Beck and also Mr. Johnson on the value and importance of their respective exhibits.

Papers.—The Chairman called upon Dr. W. E. Cooke to deliver the following communication :—

Dr. W. E. Cooke, M.D., F.R.C.P.E., D.P.H., F.R.M.S., and Mr. C. F. Hill, M.Inst.M.M., A.Inst.P., F.R.M.S.—

"Microscopical Studies in Pernicious Anæmia.
III.—The Macropolycyte.
IV.—Nuclear Degeneration in Blood Stream Cells."

A discussion followed, in which Dr. L. P. Clarke, Capt. W. S. Hoseason, Dr. J. A. Murray, Dr. J. W. Pickering, and Mr. E. J. Sheppard took part.

The following paper was then read :—

Mr. F. G. Wood—

"Micro-polarizing Crystals and their Projection."

Votes of thanks were accorded to the authors of the foregoing communications.

Announcement.—The Chairman announced that the Biological Section would meet in the Pillar Room on Wednesday, April 1st, 1931, at 6 p.m.

The proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, APRIL 15TH, 1931, AT 5.30 P.M., PROFESSOR R. RUGGLES GATES, M.A., Ph.D., LL.D., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

Charles H. Bartlett, Luton.
Lawrence Turner Fairhall, M.A., Ph.D., Newton, Mass.
Edwin Ernest Jelley, Harrow.
John William Laden, London.
Sydney Linfoot, Harrogate.

Nomination Certificates in favour of the following candidates were read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

H. V. Chandler, Salisbury, S. Rhodesia.
Harold W. Channon, Clapham Park.
Walter Garner, M.Sc., Bradford.
A. E. Jenkins, Willesden.
John W. Pickering, D.Sc., Purley.
Henry Trill, Lincoln.
Henry Williams, Fulham.

The Death was reported of Dr. John A. Miller. Elected 1891.

A vote of condolence with the relatives was passed.

Signing the Roll.—The following gentlemen present, having subscribed their signatures to the Roll, were received by the President, and formally admitted to the Fellowship of the Society :—

Mr. Frank H. Lewis.
Mr. Syed Hedayetullah.
Mr. Ernest G. Miller.

Exhibit.—Mr. J. W. Smart exhibited and described a new universal lens or light filter holder for photomicrography.

A vote of thanks was accorded to Mr. Smart for his exhibit.

Papers.—The following communications were read and discussed :—

Mr. L. La Cour—

" Improvements in Everyday Technique in Plant Cytology."

Prof. A. Gandolfi Hornyold, D.Sc., F.Z.S., F.R.M.S.—

" On the Preparation of Eel Scales."
(Read by Dr. C. Tierney.)

Votes of thanks were accorded to the authors of the foregoing communications.

Announcement.—The President announced that the Biological Section would meet in the Pillar Room on Wednesday, May 6th, 1931, at 6 p.m.

The proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, MAY 20TH, 1931, AT 5.30 P.M., PROFESSOR R. RUGGLES GATES, M.A., Ph.D., LL.D., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

H. V. Chandler, Salisbury, S. Rhodesia.
H. W. Channon, Clapham Park.
Walter Garner, M.Sc., Bradford.
A. E. Jenkins, Willesden.
J. W. Pickering, D.Sc., Purley.
Henry Trill, Lincoln.
Henry Williams, Fulham.

Nominations to Honorary Fellowship.—In recognition of the distinguished services rendered to Biological Science by the following gentlemen, Nomination Certificates to the Honorary Fellowship were read for the first time, and directed to be suspended in the Rooms of the Society in the usual manner :—

Prof. K. Fujii, Tokyo.
Prof. Victor Grégoire, Louvain.
Prof. O. Rosenberg, Stockholm.

The Death was reported of :—
Daniel Davies. Elected 1908.

A vote of condolence with the relatives was passed.

Donations were reported from :—

Prof. R. Ruggles Gates—
"Cytologia," Vol. 1, No. 1. Edited by K. Fujii.

Messrs. Chapman & Hall, Ltd.—

"Handbook of Chemical Microscopy." Vols. I and II. By Chamot and Mason.

Messrs. Longmans, Green & Co., Ltd.—

"Researches on Fungi." Vol. IV. By A. H. R. Buller.

Photomicrographic Society—

Journal, Vol. XV.—Symposium Number.

Mrs. Edmund Warner—

An Old Microscope of the Jones "Most Improved" Type, with Accessories in Case by Fairey, *c.* 1785.
A Ross Binocular Microscope with Accessories in Case.
A Watson Binocular Microscope with Accessories in Case.
A Watson Portable Microscope in Case.
A Ross Cover-Glass Gauge in Case.
10 volumes Microscopical Works.

Mr. G. F. Bates, B.A., B.Sc., F.R.M.S.—

A William Cary Type of Microscope, *c.* 1828. Signed: Duncan, Aberdeen.

Votes of thanks were accorded to the donors.

Papers.—The President called upon Dr. C. A. Hoare, D.Sc., who delivered a communication on "Transmission of Trypanosomes by Insects."

A discussion followed, in which Prof. Gates, Dr. Wenyon, and Dr. Hindle took part.

The following communications were then read:—

Prof. D. L. Mackinnon, D.Sc., F.L.S., F.R.M.S.—

"Lankester's 'Gregarine' from the Eggs of *Thalassema neptuni.*"

Dr. F. Davies, M.D.—

"The Conducting System of the Heart."

The President, Prof. R. Ruggles Gates, F.R.S., exhibited and described a Double Zygospore in Spirogyra.

Votes of thanks were accorded to the authors of the foregoing communications, and to Messrs. R. & J. Beck, Ltd., Messrs. E. Leitz (London), and Messrs. W. Watson & Sons, Ltd., for the loan of microscopes for the meeting.

The following paper was read in title:—

G. P. Gnanamuthu, M.A., F.Z.S.—

"Note on Picro-Congo-Red Staining."

Announcements.—The President made the following announcements:—

The next Ordinary Meeting of the Society will be held on Wednesday, October 21st, 1931.

The next Meeting of the Biological Section will be held on Wednesday, November 4th, 1931.

The Rooms of the Society will be closed for the Summer Vacation from August 17th to September 12th, 1931.

The proceedings then terminated.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

SEPTEMBER, 1931.

TRANSACTIONS OF THE SOCIETY.

XI.—ACROSOME FORMATION INDUCED IN ABRAXAS BY RADIATION AND PHOSPHORUS POISONING. **576. 34.**

By J. Brontë Gatenby,* Trinity College, Dublin.

(*Read May* 20, 1931.)

Six Plates.

Introduction.

This paper contains further details of the work on phosphorus poisoning already described in a preliminary note (Gatenby, 1931). In addition, a description is given of the effects of gamma radiation on the same material.

The writer wishes to thank Dr. Oliver Chance, of Dublin, for kindly lending 13·5 milligrams of radium.

Previous Work.

There is a large body of work on the effects of radium radiation on the cell. Some of this is reviewed in a previous paper (Gatenby, Mukerji, Wigoder, 1929).

Mottram (1927), dealing with the work of Packard and Crowther, who obtained sigmoid mortality curves in Drosophila eggs and *Colpidium colpoda* respectively, claims that, in the case of certain approximately

* Theresa Seessel Fellow, Osborn Zoological Dept., Yale University.

logarithmic curves obtained with bacteria and disinfectants, the probable explanation is the varying resistance of the organisms. He concludes that the curves obtained with X-radiation and β-radiation have a similar explanation, and are of importance because they show that *cells do not react towards radiation in a peculiar manner, but in the same way as living matter in general reacts towards nearly all adverse environments.* As will be seen below, the present writer is not quite in agreement with this idea—from the cytological viewpoint.

On the difficult question of just how radium radiation affects cells, Mottram states that in his investigations on *Colpidium colpoda* exposed to β-radiation, the first two histological changes are (*a*) an increase in the hyaline material (nuclear sap) of the macronucleus, which accumulates between the chromatin and the nuclear membrane, and (*b*) a derangement of the superficial mitochondria, which normally are arranged in longitudinal rows. Mottram suggests that mitotic irregularities following irradiation may be due to change in the hyaline material of the nucleus.

Working on metazoon material (mouse sarcoma), Mottram again found increase of the hyaline substance of the nucleus, beginning two days after exposure to β-rays. He describes swelling of the nuclei, the latter becoming two to four times natural size, and assuming a ghost-like appearance, the growth in size not being accompanied by increase of chromatin. The dose used by Mottram in this particular work was 20 minutes' exposure of subcutaneous nodules to radium applicator of 20 mgrs. radium element, area 15 by 15 mm., screen 0·35 mm. silver. The tumours were removed 12 hours and 1, 2, 3 and 4 days afterwards.

Some of the other main points brought out by Mottram are: (1) X-rays inhibit division of cells not dividing at time of radiation; (2) X-rays do not prevent completion of division of cells undergoing mitosis at time of radiation, though the following division will probably be inhibited; (3) dividing cells are seven to eight times more sensitive to radiation than non-dividing; (4) metaphase is the most radio-sensitive period of mitosis; (5) the nuclear sap is altered.

The fourth statement does not agree with the results of Strangeways' school, who claimed that the prophase was the most radio-sensitive period, and the idea incorporated in paragraph 2 is not supported by the work of Ruth Patten and Sylvia B. Wigoder (1930), who, working on irradiated bean roots, state: "That cells in the dividing state continue the mitotic process in a normal manner is an untenable hypothesis, since abnormalities are found in the metaphase 20 minutes after irradiation . . . indeed, the whole bulk of evidence is more in favour of the theory that X-rays produce abnormalities in the dividing cell, and may retard or inhibit the whole process."

It seems that the question of what period of mitosis is most radio-sensitive is still unsettled, and one may say difficult to settle definitely, but the views of Mottram have not recently been given the attention they deserve.

His work on the effects of radiation on the nuclear sap is particularly interesting in view of the claims of A. Dalcq mentioned below. The difficulty here is to know whether this increase in sap brings about, or follows, injury to the chromosomes.

Recently A. Dalcq (1929) has published a paper on the effects of irradiation on the gametes of Amphibia. Dalcq claims that, no matter what dosage was used, no alteration of maternal chromosomes was obtained during segmentation. He finds that irradiation of the unsegmented egg brings about, by means of the latent effect, a crisis at the time of gastrulation, more exactly at the closure of the blastopore. He mentions that the latent effect can only be explained by assuming that in some way the nuclear sap is affected, but admits that a lesion of the chromosomes (Müller) is possible also. Dalcq does not appear to be aware of the work of Mottram, who has priority in the idea of the radiation effect on the nuclear sap (*op. cit.*).

Previous Work on Cavia, Abraxas, and Lepisma.

In previous papers Gatenby and Wigoder (1929), Mukerji (1929), and Gatenby, Mukerji and Wigoder (1929), have examined the effects of X-radiation on Abraxas, Lepisma, and Cavia. More recently Gatenby (1931) has published a paper on phosphorus poisoning in Abraxas, giving a preliminary outline of the facts which had then been ascertained.

Working with X-radiation, it was shown in Cavia that the spermatocyte nuclei became aged, as shown by their spermatidiform facies, and the acrosome was secreted, outgrowth of the flagellum beginning. After severe irradiations, giant cells were formed, not by swelling, as shown by Mottram for radiated tumours, but actually by coalescence of neighbouring cells. The well-known lag phenomenon in mitosis was shown to apply also to dictyokinesis.

At about the same time R. N. Mukerji, working in the writer's laboratory, brought out some interesting facts in Lepisma spermatogenesis and oogenesis after X-radiation. He showed clearly that the separate neutral red-staining vacuoles of the Lepisma spermatocyte and spermatid remained unchanged and brightly staining even when the necrotic cells were actually falling to pieces. Mukerji also described partial metamorphosis of spermatocyte into giant spermatozoon, and showed degeneration of oocytes.

More recently Gatenby and Mukerji (1929) studied Abraxas material which had been radiated by Dr. S. B. Wigoder. This showed the formation of remarkable abortive acroblasts within the spermatocytes. These acroblasts were comparatively very large, and went over whole to the spermatids at division, but usually were absorbed before spermateleosis set in. Changes in the mitochondria occurred a few hours after X-radiation, some cells in the same nest responding differently from others. The conclusion arrived at was that the radiation had either affected the Golgi

bodies directly, or had disturbed some other agent whose function it was to prevent acroblast formation.

In further pursuit of this problem (Gatenby, 1931), it was conceived that if, as Cowdry (1928) had claimed, phosphorus poisoning brought about break-up of the Golgi apparatus, some interesting facts might be gleaned from a study of the spermatogenesis of phosphorised Abraxas. The results exceeded expectations; but while no break-up of the Golgi material took place, precocious secretion from both mitochondria and Golgi bodies was brought about, and some very remarkable changes took place.

Dosages.

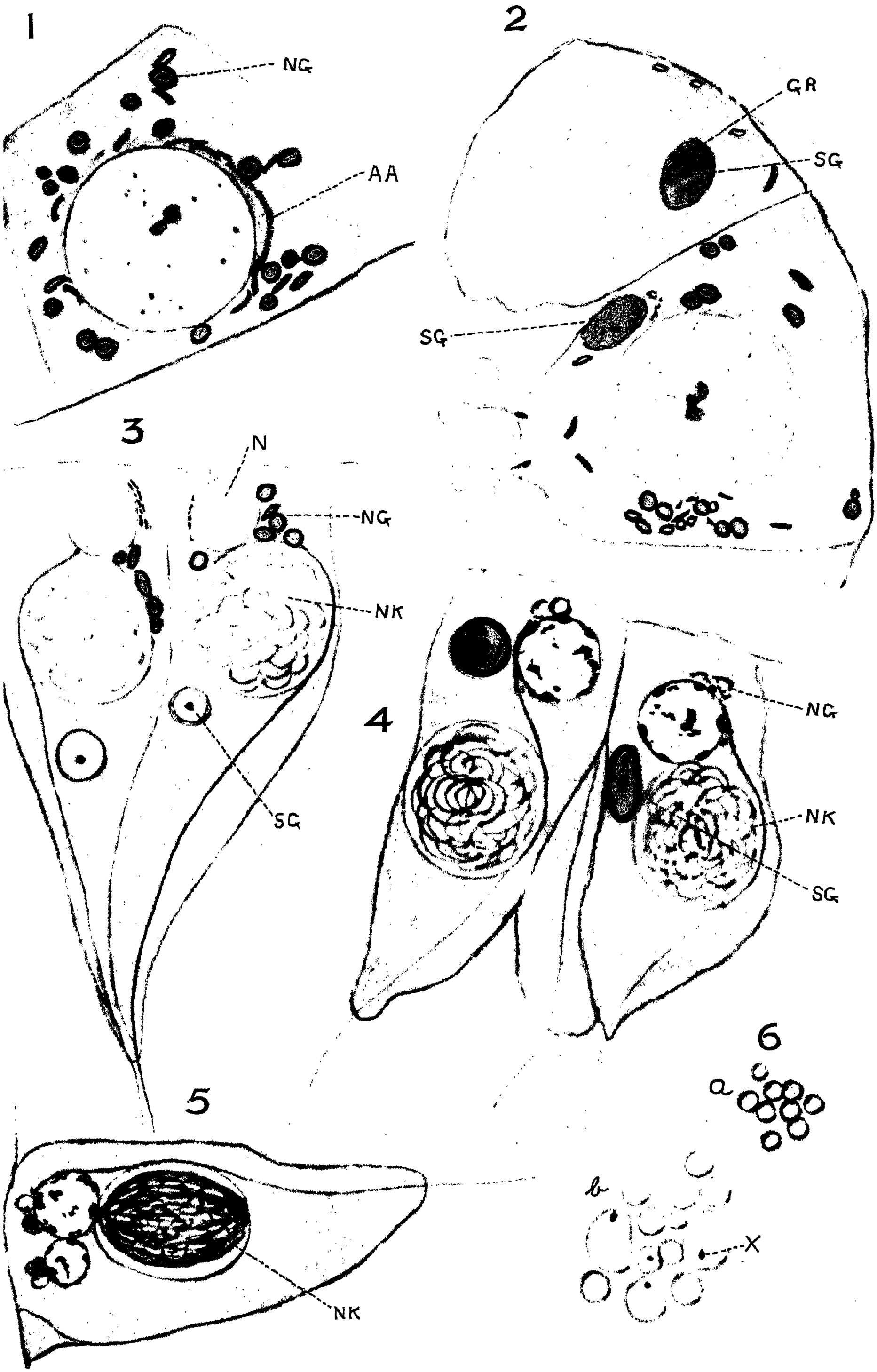
In previous work there seemed, from the inadequate data given, no basis for comparison between the dosages given by Müller and Miss Wigoder, but the recently published work of the former author states dosages. Müller's "t 1" dose is 285 r units, and the "t" dose of Müller's 1927 and 1928 papers is about 855 R units. Müller, in his latest paper, speaks of using "heavy irradiation ('t 13' or about 3,700 R units)."

Now, Mukerji found that half an hour's exposure of Lepisma to a Metalix type E X-ray tube, run at 85 KV., 2 M.A. at 23 cms. distance from the insects, was fatal in 24 hours, while with 1 to $1\frac{1}{2}$ times human erythema dose (1,000–2,000 R) the insects lived for 4 to 15 days. In radiation experiments on moth larvæ it was found (Gatenby, Mukerji and Wigoder, 1929) that 10,000 to 12,000 R killed in 4 days. With about 3,000 R, pupation and emergence in Abraxas seemed normal, this being at least twice the dose that killed Lepisma. Hanson and Miss Heys used 153 mmgs. of radium for 9 hours for their Drosophila experiments, as against 13 mmgs. used by the writer on Abraxas, usually for a longer time. But the dose used by Hanson and Miss Heys must have been very much larger than that to which the caterpillars were subjected by the present writer.

Mottram, for instance, produced swollen nuclei and other changes in the mouse sarcoma by using only 20 mmgs. radium for 20 minutes.

It should always be remembered that in mammals (Gatenby and Wigoder, 1929), and in insects (Lepisma, Mukerji, 1929), the spermatozoon appears to be the most radio-resistant of all spermatogenetic elements, and the growing and mitosing spermatocytes the least radio-resistant. Mukerji (1929), however, found the older oocytes to be more radio-sensitive than the young ones.

Finally, on the question of dosage, it can at least be said that Müller and Hanson have used doses which were well within the strength which produces many abnormalities in the germ cells of the animals studied by the writer and his associates. Müller himself mentions this when he writes of his experiments on Drosophila: "It should be noted especially that, as in mammals, X-rays (in the doses used) cause a period of extreme infertility,



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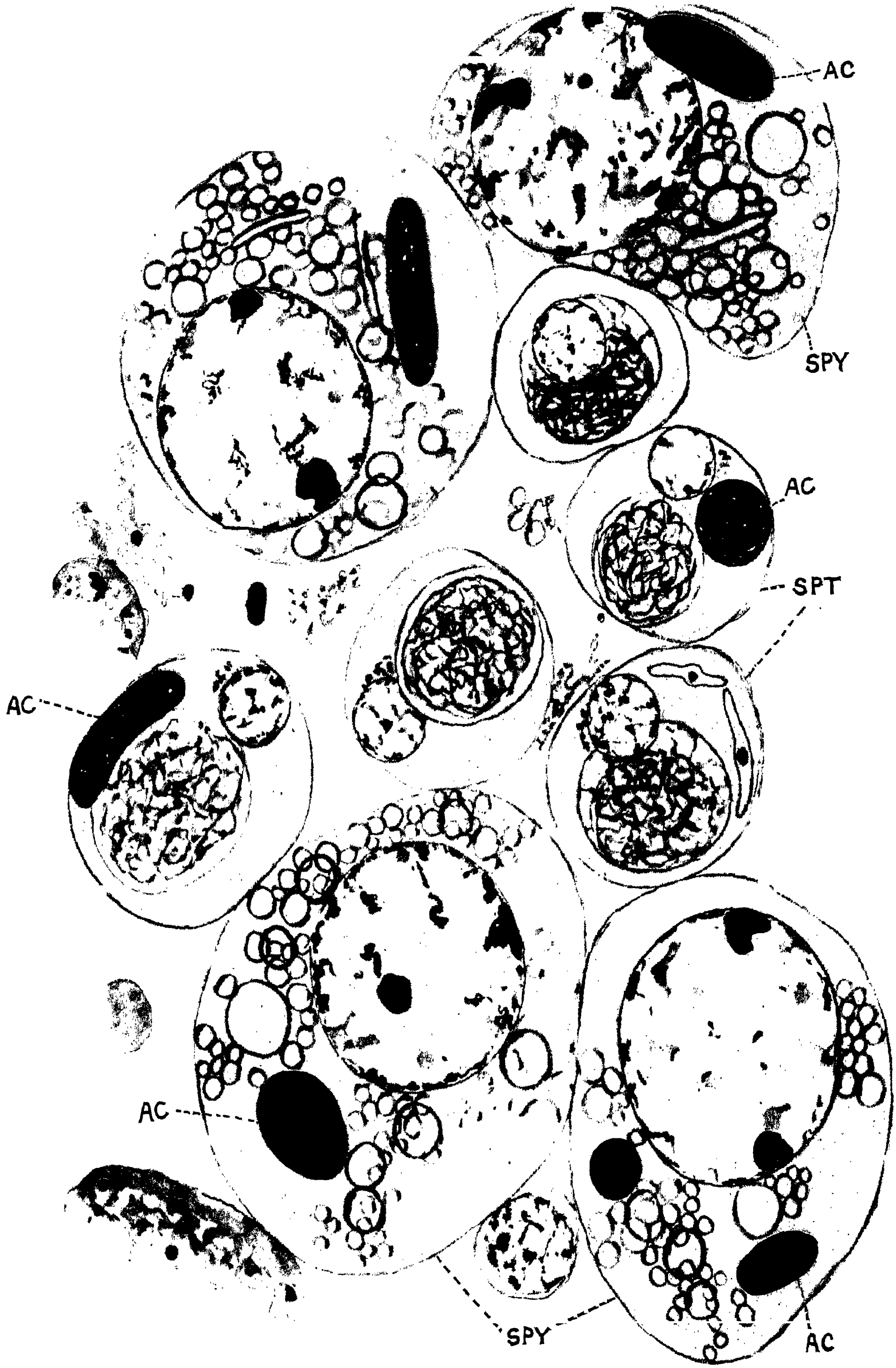

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which commences soon after treatment and later is partially recovered from. It can be stated positively that the return of fertility does not mean that the new crop of eggs is unaffected, for these, like those mature eggs that managed to survive, were found in the present experiments to contain a high proportion of mutant genes (chiefly lethal, as usual)."

Nomenclature.

In this, as in the other papers by the writer and his associates, the argentophile and osmiophile structures (dictyosomes) of the spermatic cells are called the Golgi bodies, the neutral red globules the " Vacuome " or vacuolar system. This present paper does not deal with the effect of radiation on the " vacuome." It was shown by Mukerji, in Lepisma, that the neutral red bodies are not affected by the necrotic changes in the cell brought about by X-radiation.

Technique.

The Champy iron alum hæmatoxylin method is, for purposes of studying the normal development of the spermatozoon, quite satisfactory, but there were times, during the writer's study of the experimental material, when this method proved unsatisfactory. In normal material the Golgi elements appear as crescents or scales, usually lying in a characteristic manner in the cell, but in material poisoned by phosphorus, or disturbed by radiation, the Golgi bodies swell up and, being inextricably mixed with the mitochondria, are difficult to differentiate. No such trouble occurs with Kolatschew or Da Fano slides, but the former is too expensive and the latter too capricious. In other words, we are still in need of a reliable and cheap Golgi apparatus method.

Further details of technique will be found in a previous paper (Gatenby, 1931).

Phosphorized Oil Material.

This consisted of the following: larvæ injected as described in the preliminary paper, and killed at the following times after injection:—4, 6, 9, 10, 11½, 12, 14, 15, 16, 18, 19, 30, 46 hours, and 3 days, all at room temperature: then the following at 32–35° C.—12, 14, 16, 18 hours. Some killed after 15 and 16 hours were injected with ½ strength (i.e., saturated phosphorized oil diluted by half pure oil), at room temperature. The majority of this material was prepared by the Champy iron hæmatoxylin method, some by same technique, but smeared, and finally a smaller quantity of Nassonow and Da Fano sections.

In the previous paper (Gatenby, 1931) the main outline in the formation of large acroblasts and their migration through the maturation divisions

into the spermatid was given. It remains here* to describe the acroblast formation in Kolatschew sections, and the effect of phosphorus at a temperature higher than normal.

The Kolatschew method, as is well known, consists of fixation in chrome-osmium solution, and subsequent osmication. By this method the Golgi bodies or dictyosomes appear as shown in pl. I, fig. 1, NG, and if the method is done properly, the mitochondria do not stain at all in Abraxas material, or at most are yellowish, except in the nebenkern, which is yellowish to brown.

Now, at $11\frac{1}{2}$ hours after injection of phosphorus the first sign of abortive acroblast formation may be seen as depicted in pl. I, fig. 1, AA, where a bow-like structure is applied to the nucleus. This is in reality formed of a number of acroblasts stuck together, as was clearly shown in a previous work on X-radiation (Gatenby, Mukerji and Wigoder, 1929, pl. 22, figs. 8–10). This structure nearly always stains more lightly in osmium tetroxide than does the normal Golgi body. Later, as shown in pl. 22, fig. 11, of the previous paper (Gatenby, Mukerji, Wigoder, 1929), this early abortive acroblast comes off the nucleus and lies, an ovoid structure, in the ground cytoplasm.† Almost always by this time a densely staining granule has appeared, usually in the middle of the abortive acroblast: this is the abortive acrosome. Now, practically always, the cortex of the abortive acroblast is much less osmiophile than the normal Golgi bodies. This is shown in pl. I, figs, 2, 3, and pl. II, figs. 8, 9, 10 and 11. With osmium the acrosome granule stains intensely black in Kolatschew preparations. These conditions of staining persist even when the large abortive acroblasts are being sloughed off the lengthening spermatid (pl. II, fig. 11).

The fate of the abortive acroblast through the maturation divisions was described in the previous paper. In material since examined it was found that occasionally, though not always, the abortive acroblast became caught up in one of the asters, as shown in pl. II, fig. 10, and pl. IV, fig. 26, and eventually passed whole into one of the daughter cells. In other cases it seemed just to lie stranded in the cytoplasm, and thus was carried into one of the daughter cells.

It will be noted that in the Champy iron alum hæmatoxylin preparations (smears) the large abortive acroblasts (pl. I, fig. 2) are drawn as peculiar net-like bodies. This is exactly how they look, the acrosome being a dot, relatively less dark than by the Kolatschew method. The writer is unable completely to account for the different appearances of these bodies under different techniques. In pl. I, fig. 2, the structure is drawn especially carefully so as to give a correct idea; the cortex looks like a kind

* All these experiments have been repeated this year, with similar results, only some of the larger bodies shown black in pl. I, fig. 7, appear in the new slides to have some connection with spindle bridges. An investigation of the new material is proceeding (July 24, 1931).

† In the previous paper (Gatenby, 1931) the abortive acroblast was found forming in the cytoplasm, sometimes away from the nucleus. This was in smears. It is rather difficult to tell whether the smearing does not pull off the acroblasts at this period.

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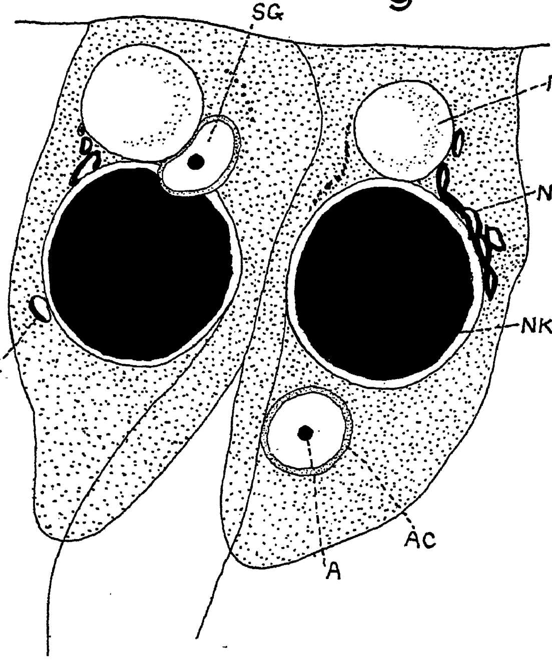

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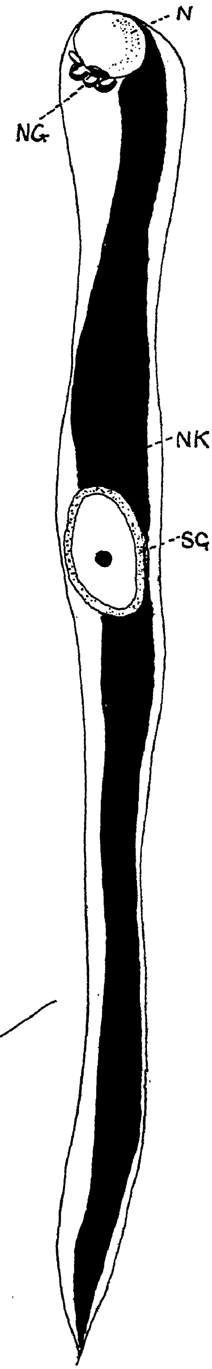

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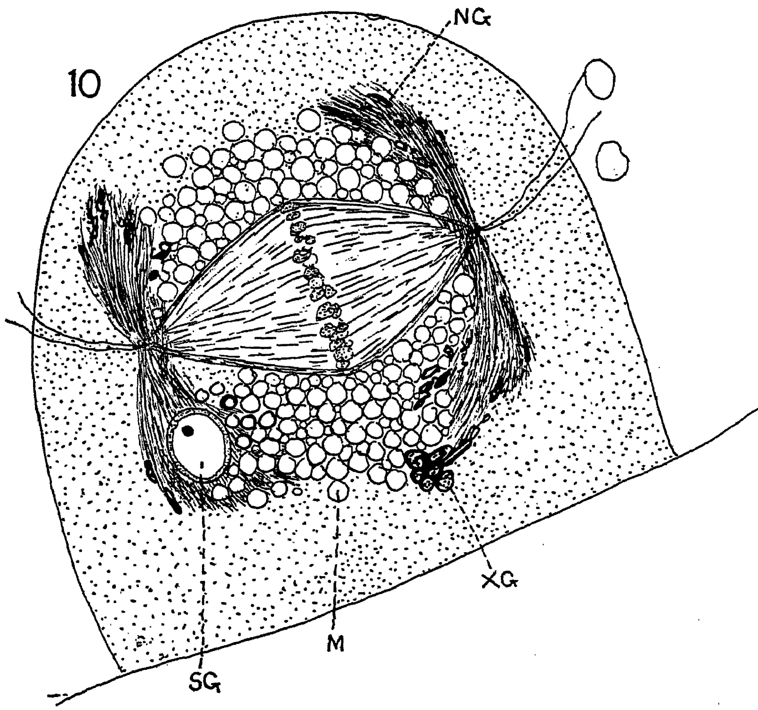

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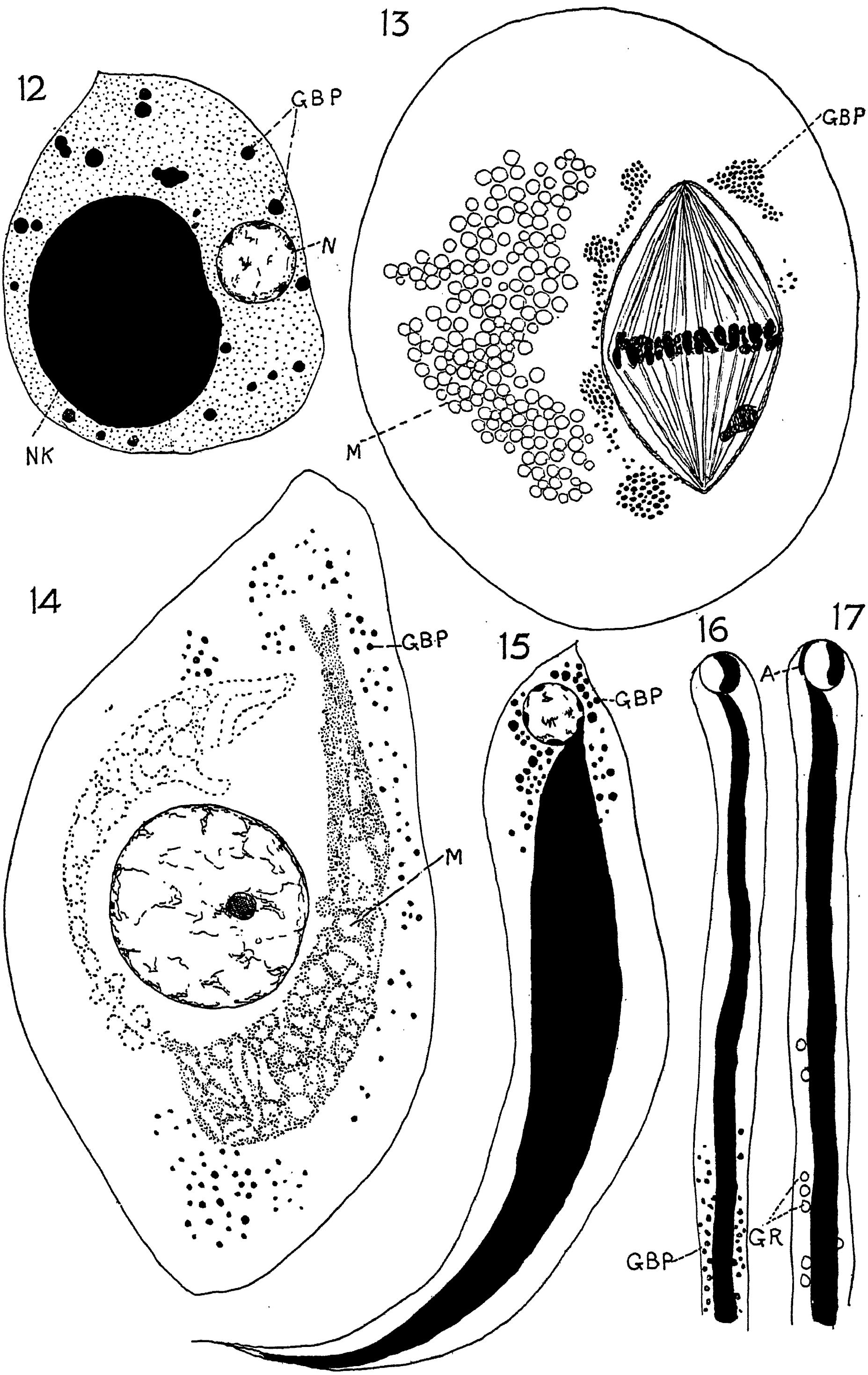

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of net, whereas the bead reposes in a medulla which is "archoplasmic" in appearance. It is not possible to say whether the Champy iron hæmatoxylin facies shown in pl. IV, figs. 24–26, is due to the cortex or to the more intensely coagulated and stained medulla, probably the latter.

In pl. I, fig. 7, the cells drawn are not much differentiated by iron alum, and the abortive acroblasts look solid.

Now, as was mentioned in the previous paper (Gatenby, 1931), one out of four spermatids derived from the two divisions of the spermatocyte receives the large abortive acroblast, as well as a number of other more or less normal Golgi bodies (see pl. II, fig. 10, normal Golgi bodies, NG, slightly abnormal ones, XG, abortive acroblast, SG). Once arrived in the spermatid, the abortive acroblast may get on to the nucleus, as in pl. II, fig. 8, where it is trying unsuccessfully, one concludes, to deposit its over-sized acrosome on the nucleus. The writer has never seen an over-sized acrosome fixed on to the nucleus, and assumes that the acroblast, when of this large size, is non-functional. In the previous paper (Gatenby, 1931, pl. 22, fig. 10) it was shown that occasionally smaller induced acroblasts did manage to apply their acrosome to the nucleus. Apparently in the very large acroblasts the bead cannot pass through the cortex, even though the latter is closely applied to the nucleus, as depicted in pl. II, fig. 8.

Now, in no case could the writer be sure that the spermatids derived from a spermatocyte containing an abortive acroblast failed to receive a quota of normal Golgi bodies. For though one of the four cells contains a large abortive acroblast, it also has a number of normal bodies from which an apparently normal acrosome can be formed. This normal process is shown taking place in pl. I, figs. 3 and 4, and pl. II, fig. 11.

Thus it can be concluded that the spermatid is able to induce the acrosome-producing effect on the Golgi bodies even though an abortive acrosome is already present.

The Effect of Raised Temperature and Phosphorized Oil.

In pl. III, figs. 12–16, is a series of drawings of cells which had been treated as before, but the temperature raised to 30–32° C. The caterpillars were injected and placed immediately in an incubator at the temperature stated. Cursory examination of smears or sections of such material killed from 10 to 16 hours after injection showed that all the categories of cells of the testes contained many densely staining small granules, GPB in pl. III, figs. 12–16, but no normal Golgi bodies.

In the spermatocyte from a smear, drawn in pl. III, fig. 14, the mitochondria are at M, and a very large number of different-sized granules at GBP. In pl. III, fig. 13, a spermatocyte in mitosis, the mitochondria and granules are clearly differentiated. There is a tendency for clouds of granules to lie around the asters. In fig. 12 is a spermatid with normal-sized nebenkern (NK) and the same granules; in fig. 15, a later stage, with the granules

distinctly around the nucleus, but no normal acrosome formation; and in fig. 16, a still later stage, with drifting granules (GBP) and, so far as one could see, no acrosome to the nucleus (fig. 17 is a control).

Now, in stages like pl. III, fig. 15, it is quite certain that there are more granules than the normal number of Golgi bodies. Unless the original Golgi bodies have grown and suddenly fragmented, it can only be concluded that all of these stainable bodies are not true Golgi bodies. It is obvious that 30–32° C. is too high a temperature, and until intermediate temperatures between 20°–30° C. have been tried, it is not much use discussing these stages.*

It should be pointed out that a sudden rise in the temperature prevents, and does not increase, growth of abortive acroblasts.

Induced Secretion from Mitochondria.

In the previous paper on this subject it was mentioned that in some of the phosphorized material the mitochondria of spermatocytes could form long tubes, which passed whole into the spermatid and there produced a secretion bead. It was suggested that this process might have some connection with the formation of tail sheath substance described for certain insects by Bowen. In pl. IV, fig. 26, of the present paper is a spermatocyte division showing some mitochondria in the form of tubes (EM). In pl. IV, figs. 24 and 25, the two spermatids exhibit such tubes (EM), but containing secretion (SS). The fate of these peculiar tubes has not been followed out.

In the previous paper by the writer, Mukerji, and Wigoder (1929, in pl. 20, fig. 5, M) a mitochondrial vesicle with contained secreted granule is depicted after X-radiation. In the present paper, on pl. I, figs. 6*a* and *b* are normal and phosphorized cell mitochondria. Many such examples as in fig. 6*b*, X, are to be found in cells with abnormal cytoplasm caused by phosphorus necrosis.

The reason for the formation of the tubes (fig. 24) rather than spheres (as in fig. 7) is unknown, but the secretion process in each case is probably the same thing.

Radium (Gamma) Radiation.

The Ra element used amounted to 13 milligrams, contained in platinum needles which were 0·6 mm. thick, and absorbed 99·98 p.c. of beta rays and about 6–7 p.c. of gamma. The needles were placed in rows inside a tube lying on its side, and turned towards a light, so that the larvæ, constantly walking over the needles, were exposed to the radiation.

* New material killed 6 hours after injection shows fragmentation of the Golgi bodies on a large scale. These granules depicted on pl. IV, figs. 12–16, are all derived from the original Golgi bodies (Journ Exper. Zool., 1931).

The material consisted as follows :—

Time.	*Temperature.*
4 hours	35° C.
4½ hours	35° C.
17 hours	room
24 hours	room
2 nights (48 hours)	room
3 nights (72 hours)	room
week (168 hours)	room

The larvæ of 2, 3 and 7 days were irradiated during the night and fed in the daytime, during which they were removed from the radium, and the actual times of irradiation are placed in brackets after the time at the end of which the larvæ were killed. According to the theories of radiation, the caterpillars, while being exposed to a majority of gamma rays, were also influenced by a proportion of beta rays.

Of the three experimental methods used—short X-radiation, phosphorus poisoning, and gamma radiation—the latter gave some very characteristic results. It is not suggested that comparable results could not have been procured by modifying the X-radiation treatment, but, as it was given, the gamma radiation certainly produced some quite different results.

These are shown on pl. IV, figs. 18–23. In the first place, gamma radiation killed some of the cells in the same nest, and passed over or did not affect others. This is shown in fig. 18, dead cells (D) staining more heavily than the live ones (L). The cells in question are spermatogonia just entering the prophases, and the larvæ had been exposed overnight (17 hours) to the platinum needles of radium element.

In the second place, gamma radiation caused inequality of growth and division rates in the same type of cells in the same nest. Such is shown in pl. IV, fig. 23, where there are "resting" spermatocytes (SPY), dividing spermatocytes (SPYD), and advanced spermatids (SPT) all in the same nest. This effect is probably only another expression of the first-mentioned phenomenon—the occurrence of both living and dead cells in the same nest (fig. 18).

Again, the third point is the well-known lagging effect caused by radiation, as shown in pl. IV, figs. 21 and 22, where the nuclei have failed either to get to, or to keep, their position at the head of the spermatid. Also, in the cell in fig. 21, one or more chromosomes have failed to become absorbed properly in the nucleus, and form a lump on one side. This, again, is probably another expression of the causation of inequality of growth and differentiation by gamma radiation.

Finally, of such gross changes brought about by gamma radiation, we have the production of giant cells, such as is shown in pl. IV, fig. 19, after 7 nights' irradiation. This is rare in the present material. The method of origin of such a giant cell (2½ to 3 times normal size) is unknown, whether by union of two or more cells or by stimulus of growth, but the former

explanation is likely, because more than two centrosomes existed in the cell in question.

All these changes are, as has been remarked, gross changes, and evidently follow upon, and are the result of, subtler effects in both nucleus and cytoplasm. In pl. IV, fig. 20, is a cell in the prophases of the maturation division, and showing what are very typical radium effects. The Golgi bodies (G), ordinarily at this stage stainable crescents, are now very clear swollen globules, tending to lie in chains. Mitochondria exist as smaller and paler vesicles lying in the same position (M). This peculiar globular and swollen appearance of the Golgi bodies is very characteristic of all the gamma radiated material in the writer's possession. It is as if the gamma radiation causes the Golgi elements to become over-emphasized. The vesicular condition depicted in pl. IV, figs. 20 and 23, in Champy iron alum hæmatoxylin preparations, is only found in spermatids in which the acrosome is about to be secreted. In such material the mitochondria seem less radio-sensitive, and nuclear changes, while being present, are of the lag-effect nature, and do not consist of actual change in morphology as occurs with the Golgi elements.

In a certain small proportion of gamma radiated material, abortive acroblast formation does take place, as shown in pl. I, fig. 4, SG. In this material many nuclear abnormalities, especially on the spermatids, are noticeable, as in pl. I, fig. 5, where two nuclei have been formed. Normal acroblasts were attached to each nucleus.

Discussion.

We have now to try to compare the effects of radiation and injury caused by poisoning. In the first place, radiation causes lag phenomena in the nuclear constituents which are absent in at least the same stage of injury in phosphorus poisoning. It is a remarkable fact that while the cytoplasmic inclusions may be in a completely vesiculated and seemingly unhealthy condition as a result of the phosphorus (pl. I, fig. 6*b*), the amphiastral figure is normal, no lag occurs, and the chromosomes exhibit no tendency to fuse. Thus the present writer is unable to agree fully with Mottram's idea that radiation kills cells in the same way as deleterious agents like phenol. The destruction of cells by radiation, which probably amounts, as Hanson points out, to destruction by β-rays, is something involving the nucleus and amphiastral figure in a way not found with poisons like phosphorus or arsenic.* On these grounds alone it is not to be expected that poisons like phosphorus would be so active in producing mutations. On the other hand, heat might act directly on the nucleus, and the raising

* The experiments with arsenic could not be completed in the season of 1930. The results procured were unlike those with phosphorus.

of temperature would probably, by hastening on and unbalancing parts of the germ cell cycle, produce effects somewhat comparable to X-rays.

So far as our modern cytological technique goes, it has been shown in this paper that the most sensitive cell organ is probably the Golgi body. The Golgi body is the first to respond to phosphorus poisoning, to X and to gamma radiation. As has been pointed out in other papers, we cannot say at present whether this sensitivity is controlled directly by the nucleus, and whether the behaviour of the poisoned or radiated Golgi elements is the expression of a direct or indirect effect. From the fact that, after the appearance of the abortive acroblast, the spermatids form and continue metamorphosis, it might perhaps be concluded that the nucleus had not been seriously affected, and that the precocious behaviour of certain Golgi bodies constitutes an escapade for which they alone are responsible.

When one tries to analyze the whole effect of radiation or poisoning by phosphorus, one gets something like this:—The cell is temporarily incapacitated, and endeavours to bring its normal development to a successful close. The abortive acroblast appears, some of the mitochondria secrete sheath substance, and thus the cytoplasmic expression of spermateleosis is brought about. But the larva recovers from the treatment and the cell picks up the threads of its normal development, maturation mitoses proceed, and ultimately outwardly normal sperms are formed. But the abortive acroblast cannot be absorbed, immediately and completely, and remains in the cell during the various post-spermatocyte stages, a reminder of the time when the cell was at a crisis.

It may be asked: Why does the abortive acroblast appear at all? It has previously been pointed out that there are two possible explanations of this—one the idea that the Golgi body has been directly stimulated, the other that the controlling factor has been temporarily incapacitated, and the Golgi body, now released from this factor, continues to develop in an indiscriminate manner.

Since it has been shown that phosphorus poisoning has much the same effect on abortive acroblast formation as radiation, it seems indicated that the first possible explanation given above, namely, stimulation, is extremely unlikely. It is much more likely that this process is actually due to incipient cell degeneration, from which, as has been pointed out, the cell may recover. Again, therefore, we can say that the effect of X-radiation is deleterious, and does not add in any way to the activity of the cell in the sense of stimulation.

Mottram, from his experiments on Colpidium, concluded that cells do not react in a peculiar manner towards radiation. While the present writer agrees in part with this statement, it should be remembered that phosphorus has not so far been found to produce spermatidiform spermatocyte nuclei and lag phenomena in mitosis, whereas radiation does.

In trying to estimate the value of the evidence produced in this paper with regard to the sensitivity of the various constituents of the cytoplasm, emphasis should be given to the fact that all the bodies lying within the

cytoplasm metamorphose at different speeds during sperm formation. Of these elements, the Golgi bodies move at the highest speed and metamorphose most quickly. They pass up to the spermatid and secrete the acrosome, and, then finished, drift down the lengthening cell. The mitochondria, on the other hand, have a slower task to perform. Is it not possible that the apparently greater sensitivity of the Golgi bodies is but the expression of their normal rapidity of metamorphosis, hastened on by a kind of necrosis, and that the slower response of the mitochondria is, in the same way, due only to their natural rate of metamorphosis ?

With radium radiation, different lag effects of all the various bodies on the cytoplasm and nucleus are observable. Gamma rays evidently scatter injuries indiscriminately.

To some students of development it may appear remarkable that the cell, once having abortively induced acrosome formation, is later able to reproduce the normal acrosome secretion effect, after recovery from the temporary injury. It is certain that the function of acrosome formation is not a single mechanical action which, when once completed, cannot be completed again.

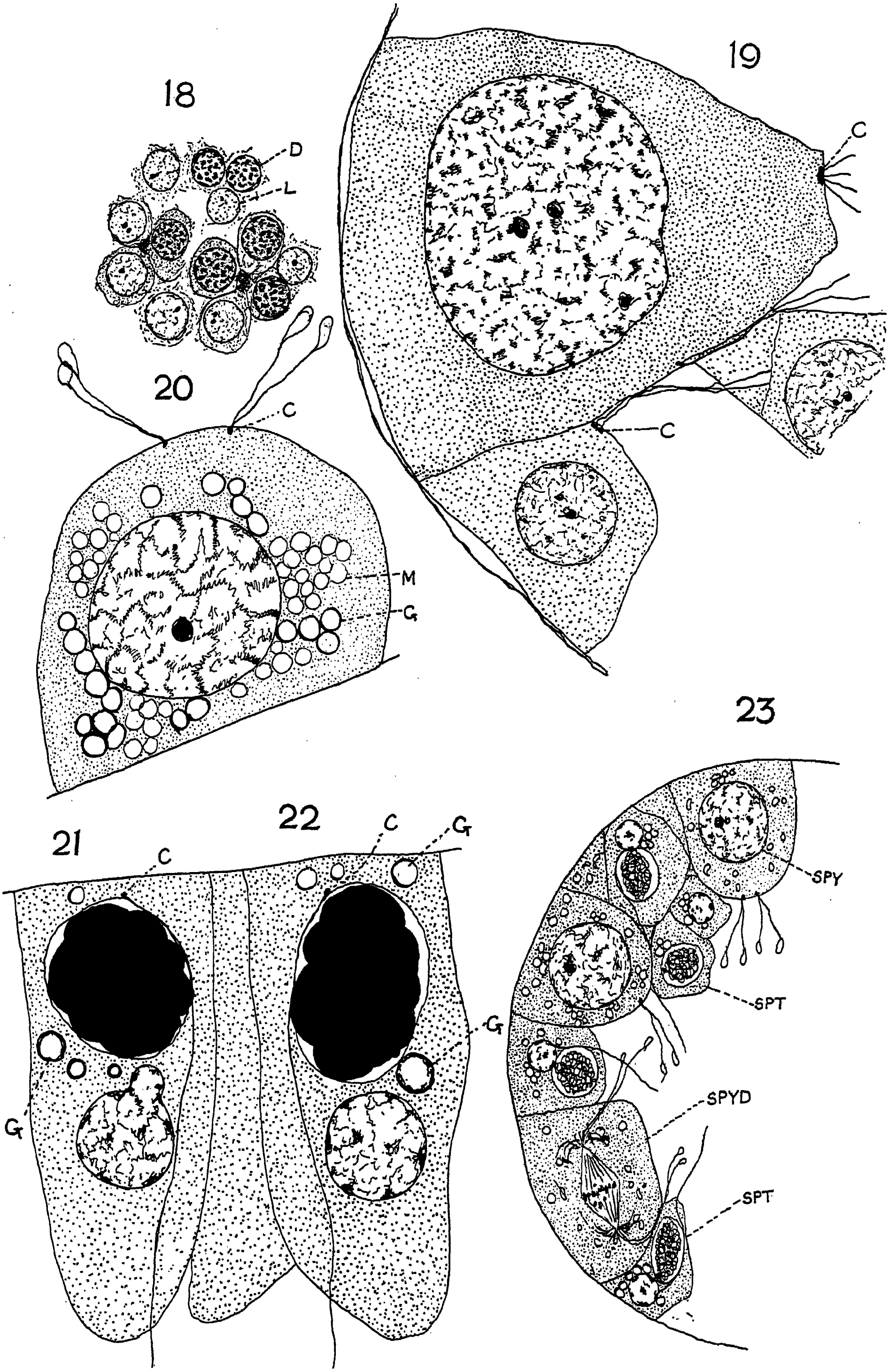
There is one point about relative damage by X-radiation to various stages of spermatogenesis which may be mentioned. Radiation affects the spermatozoa least of all, and in spermatozoa the nuclear sap (karyolymph) is possibly altogether absent. If, as Mottram suggests, the damage to nuclei is really through alteration of the nuclear sap, the differential effects on various stages of spermatogenesis (including the less sensitive closely knit spermatogonial nuclei) would be explained. An objection to this is that the nuclear sap of growing nuclei does not appear to differ in quantity from that of older and more radio-resistant nuclei, e.g., nuclei of neurones, etc.

Summary of Conclusions.

Radiation.

1. In lepidopterous testes the various categories of germ cells are arranged in nests, the individual cells of which lie very closely together. Each cell is connected to its neighbour by a spindle bridge, so that the physiological development of all the cells in a nest is equal. After X or gamma radiation, not all the cells in the same nest are affected equally, some cells remaining normal (pl. IV, fig. 18). Such cells must have escaped damage to vital parts. It is therefore always possible for some cells to come through one radiation without perceptible damage. Even though connected to apparently normal cells by spindle bridges, cells which have been hit fall back in their subsequent development.

2. Radiation produces temporary or permanent injury according to the length of exposure and strength of dose. This injury is characterized by the simultaneous production of abnormalities in both nucleus and cytoplasm.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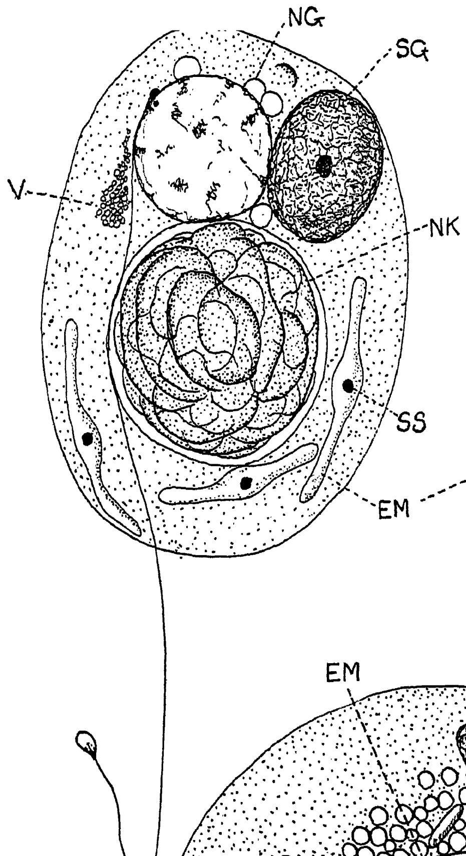

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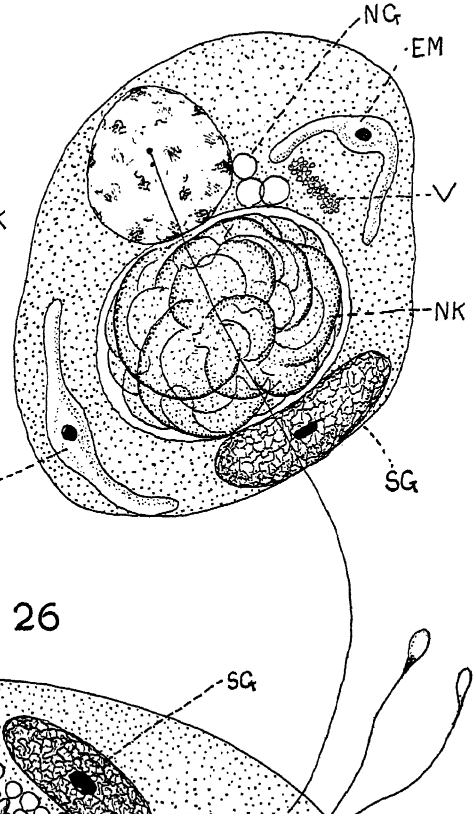

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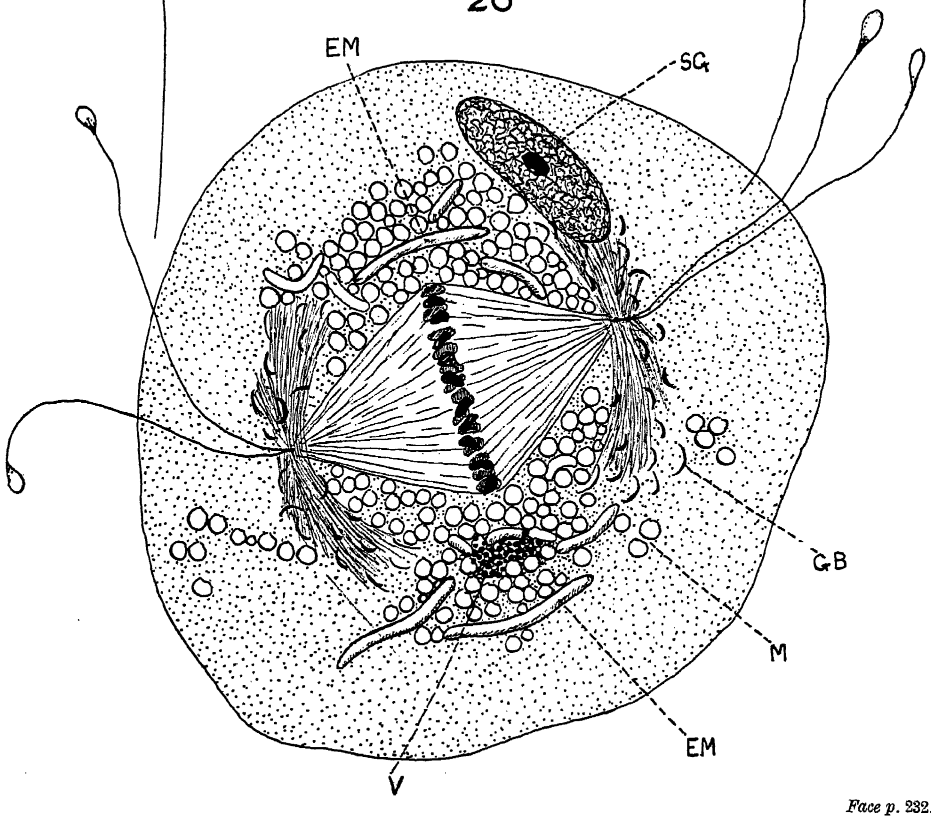

Face p. 232.

In the nuclear and amphiastral constituents the injury is shown by lag phenomena, already well known—cells, nuclei, cell inclusions, and parts of cell inclusions being incapacitated in varying degrees according to strength of dose (figs. 21–23).

Genetically these cytological changes are outwardly expressed by the production of laboratory monstrosities, caused presumably by the lag phenomena in those cells whose function it is to produce various organs and parts of organs.

3. In lepidopterous germ cells radiation produces the following cytological changes :—(*a*) giant cell formation (pl. IV, fig. 19) ; (*b*) rounding up of Golgi crescents (pl. IV, fig. 20) ; (*c*) differential growth or development phenomena (pl. IV, figs. 18, 21, 22, 23), i.e., lag.

4. It is concluded that the changes described in this and the previous paper by Gatenby, Mukerji, and Wigoder (1929) are not due to stimulation by radiation, but to injury. Undeveloped male germ cells, incapacitated either by radiation or poisoning, always endeavour to bring their development to a successful close. No explanation of this characteristic of living material can be offered by the present writer.

Phosphorized Oil.

1. Larvæ of Abraxas injected with a minute drop of phosphorized oil are not outwardly affected, and pupate and emerge quite normally. They may be sterilized.

2. Eleven and a half hours after injection of the phosphorized oil, necrotic changes begin to occur in the male germ cells.

3. Very large abortive acroblasts appear in the spermatocytes produced by the running together of a number of Golgi bodies (pl. I, fig. 7).

4. In sectioned testes at 11½ hours some of the Golgi bodies are seen to become attached temporarily to the spermatocyte nucleus, and form a crescentic figure (pl. I, fig. 1). Later these come away from the nucleus, and the whole structure appears usually as an ovoid body containing a single secreted granule (pl. I, fig. 2, pl. IV, figs. 24–26).*

5. In Kolatschew preparations (chrome-osmium) the granule (acrosome) becomes densely black, the acroblast cortex paler. In Champy iron alum hæmatoxylin the acroblast appears as a network structure, the granule relatively less stainable. Rarely two or more abortive acroblasts appear in one cell. There are always unchanged Golgi bodies left in the spermatocyte.

6. During maturation divisions the abortive acroblast is carried over whole to one of the spermatids (pl. II, fig. 10, pl. IV, fig. 26, and figs. 24 and 25). The abortive acroblast sometimes adheres to the aster (pl. II, fig. 10).

7. In the spermatid the abortive acroblast may become attached to the nucleus (pl. II, fig. 8), but never appears able to deposit its granule on to

* For the appearance seen in smears refer to the previous paper (Gatenby, 1931).

the latter. It drifts down the lengthening spermatid (pl. II, figs. 9 and 11), while the remaining normal Golgi bodies proceed to acrosome formation.

8. In some cases the mitochondria of spermatocytes run together to form tubes (pl. IV, fig. 26), which are carried whole to spermatids (pl. IV, figs. 24–25), where they secrete a granule supposed to be comparable to the tail sheath substance of the spermatozoon.

9. In cases where the cytoplasmic structures are badly injured, the mitochondria may become larger, paler, and secrete a bead (pl. I, fig. 6*b*, fig. 6*a* control).

10. Phosphorus-injected larvæ, heated to 30° C., give quite different results from those at room temperature. In pl. III, figs. 12–16, various categories of cells are shown. In these, the normal vesicular Golgi bodies do not occur, nor are abortive acroblasts ever seen. The granules present are dense chromophile bodies of different sizes. They appear to be much more numerous than the ordinary Golgi bodies, and are believed to be formed by fragmentation of the latter at about 6 hours after injection.

Differences between Radiation and Phosphorus Necrosis.

1. Radiation necrosis produces lag phenomena in the amphiastral figure, and ageing of nuclei. Phosphorus affects the cytoplasm long before necrotic changes take place in the nucleus.

2. Phosphorus necrosis is more easily recovered from than irradiation.

Neutral Red "Vacuoles."

1. These are shown on pl. IV, figs. 24–26. No marked changes were discoverable either by radiation or phosphorus.

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DESCRIPTION OF PLATES.

Lettering.

A. acrosome. AA. (incipient) abortive acroblast. AC. cortex of abortive acroblast. C. centrosome. D. dead spermatogonium. EM. body formed from mitochondria. G. Golgi body. GBP. granules supposed to be Golgi bodies. GR. granules, or normal Golgi remnants (fig. 17). L. living spermatogonia. M. mitochondria. N. nucleus. NG.. normal Golgi body. NK. mitochondrial nebenkern. SG. abnormal acroblast (Golgi body). SPT. spermatid. SPY. spermatocyte. SPYD. abnormal dividing spermatocyte. SS. secretion granule. V. neutral red-staining vacuole. X. secretion granule in mitochondrion. XG. slightly abnormal Golgi body.

PLATE I.

All Kolatschew Preparations.

Figs. 1, 2, 3 and 7, from phosphorus-treated larvæ, killed 11½ hours after injection. Figs. 4 and 5 from radium-treated larvæ (17 hours).

Fig. 1.—Spermatocyte nearly full-grown, showing incipient acroblast formation.

Fig. 2.—Two spermatocytes showing abortive acroblasts.

Fig. 3.—Spermatids showing normal Golgi bodies *in situ*, and drifting abortive Golgi bodies (SG.).

Fig. 4.—Same as before in radium material.

Fig. 5.—Radium spermatid with two nuclei.

Fig. *6a*.—Normal mitochondria to compare with next figure.

Fig. *6b*.—Mitochondria from phosphorus-poisoned cytoplasm, showing secretion, X.

Fig. 7.—Part of a Champy iron alum hæmatoxylin smear from 16-hour material, somewhat under-differentiated, showing spermatocytes and spermatids.

PLATE II.

All Kolatschew preparations. The "nebenkern" in figs. 8, 9 and 11 have been blackened in. Phosphorus treatment.

Figs. 8 and 9.—Two spermatids showing abortive acroblast fixed on to nucleus in one case, drifting down in the other (11½ hours).

Fig. 10.—Spermatocyte division showing abortive acroblast fixed on to aster, and slightly abnormal (clogged) Golgi bodies at XG (11½ hours).

Fig. 11.—Spermatid showing normal acrosome formation and drifting abortive acroblasts (14 hours).

PLATE III.

Figs. 12–16.—Phosphorus-treated, killed 10–16 hours after injection, incubated 30–32° C. In each case supposed Golgi bodies marked GBP.

Fig. 12.—Spermatid.

Fig. 13.—Spermatocyte division.

Fig. 14.—Full-grown spermatocyte.

Figs. 15 and 16.—Two stages in sperm formation.

Fig. 17.—Control spermatid.

PLATE IV.

All figures from Champy iron alum hæmatoxylin preparations of radium (gamma) radiated larvæ.

Fig. 18.—Smear of spermatogonial nest, showing some nuclei dead (D), some living (L) (17 hours).

Fig. 19.—Giant spermatocyte, with at least two pairs of centrosomes (week).

Fig. 20.—Typical radium spermatocyte (young), showing peculiar appearance of Golgi bodies (2 nights).

Figs. 21 and 22.—Two abnormal spermatids showing lag, and nuclei out of position.

Fig. 23.—Shows lag in spermatid nest, all cells in different stages.

Figs. 24–26.—Drawn from combined smears and sections, Champy material. Phosphorus (19 hours).

Figs. 24 and 25.—Spermatids showing included mitochondrial tubes with secretion.

Fig. 26.—Spermatocyte showing tubes without secretion.

XII.—OBSERVATIONS ON POND LIFE, WITH SPECIAL REFERENCE TO THE POSSIBLE CAUSATION OF SWARMING OF PHYTOPLANKTON. 581

By S. C. Akehurst, F.R.M.S.

(*Read December* 17, 1930.)

Seven Text-Figures.

Introduction.

Very little is at present known in regard to the causes which underlie the swarming of plankton. To gain evidence on this question we were, by the courtesy of the Head Master of Ludgrove School and W. A. Vernon, Esq., enabled to work continuously for four years on the ponds situated on the two estates—Ludgrove, adjoining Hadley Woods, and Vernon Pond, in the vicinity of East Barnet. In addition, Mr. A. Aubin, in response to a request for some details of his own work, very generously placed at our disposal three years' record of the Jersey Waterworks.

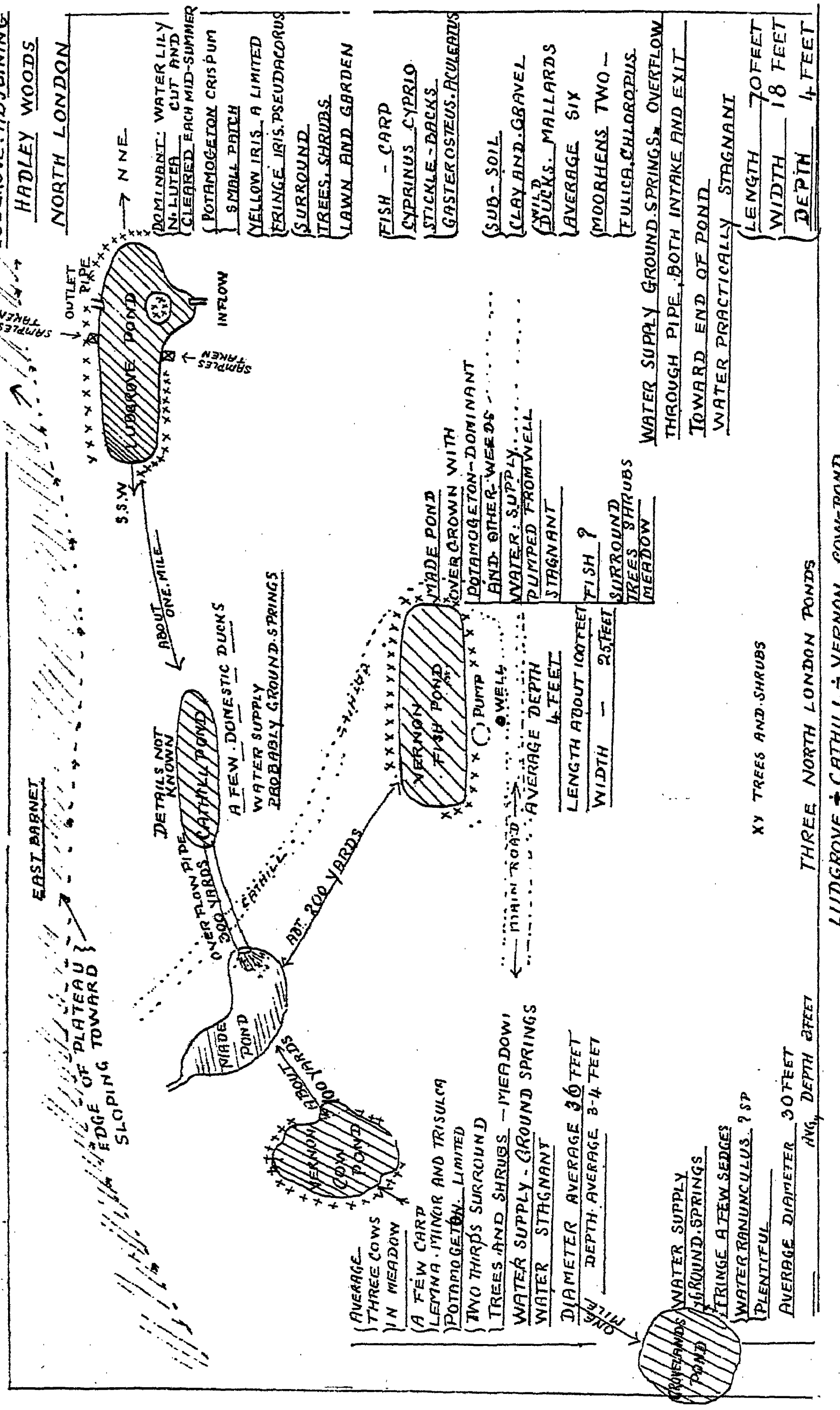
The phenomenon of swarming concerns the rise in numbers and decline of one out of many species of phytoplankton existing in the same water at the same period, such variations in quantities occurring in association with a constant food supply.

Any attempt to correlate the chemical and physical factors necessary for plant growth with rapid development of a single genus for the most part fails (Wimmer (1929); Atkins and Harris (1924)), since chemical factors are comparatively stable, whilst physical are constantly varying over periods of from a few days to a few weeks.

Other factors must play a part, and it is these factors with which we propose to deal. They consist, we suggest, mainly in a complicated action of certain toxins.

We have retained the familiar term toxin, the definition of which, however, will be as follows: "An excretion product or products of undefined chemical constitution which may also serve as an accessory food and may inhibit or stimulate growth."

Two unfamiliar botanical terms, "oil groups" and "starch groups," will also be employed, the meaning of which will become clear as we proceed.


DIAGRAMMATIC
EAST BARNET
BARNET
"LUDGROVE" ADJOINING
HADLEY WOODS
NORTH LONDON
NNE
S.S.W.
EDGE OF PLATEAU SLOPING TOWARD
OUTLET PIPE
SAMPLES TAKEN
INFLOW
LUDGROVE POND
DOMINANT: WATER LILY N. LUTEA CUT AND CLEARED EACH MID-SUMMER
POTAMOGETON CRISPUM SMALL PATCH
YELLOW IRIS. A LIMITED FRINGE IRIS. PSEUDACORUS
SURROUND TREES, SHRUBS LAWN AND GARDEN
FISH - CARP CYPRINUS CYPRIO
STICKLE-BACKS GASTEROSTEUS. ACULEATUS
SUB-SOIL CLAY AND GRAVEL
WILD DUCKS. MALLARDS AVERAGE SIX
MOORHENS TWO - FULICA CHLOROPUS
WATER SUPPLY GROUND SPRINGS. OVERFLOW THROUGH PIPE, BOTH INTAKE AND EXIT TOWARD END OF POND.
WATER PRACTICALLY STAGNANT
LENGTH 70 FEET
WIDTH 18 FEET
DEPTH 4 FEET
ABOUT ONE MILE
DETAILS NOT KNOWN
CATHILL POND
A FEW DOMESTIC DUCKS
WATER SUPPLY PROBABLY GROUND SPRINGS
OVERFLOW PIPE 300 YARDS
CATHILL
ABT. 200 YARDS
MADE POND
VERNON FISH POND
PUMP
WELL
MAIN ROAD
MADE POND OVERGROWN WITH POTAMOGETON-DOMINANT AND OTHER WEEDS
WATER SUPPLY PUMPED FROM WELL
STAGNANT
AVERAGE DEPTH 4 FEET
LENGTH ABOUT 100 FEET
WIDTH - 25 FEET
FISH ?
SURROUND TREES SHRUBS MEADOW
ABOUT 100 YARDS
VERNON COW POND
AVERAGE THREE COWS IN MEADOW
A FEW CARP
LEMNA. MINOR AND TRISULCA
POTAMOGETON. LIMITED
TWO THIRDS SURROUND TREES AND SHRUBS - MEADOW
WATER SUPPLY - GROUND SPRINGS
WATER STAGNANT
DIAMETER AVERAGE 30 FEET
DEPTH. AVERAGE 3-4 FEET
ONE MILE
TROTTERS POND
WATER SUPPLY GROUND. SPRINGS
FRINGE A FEW SEDGES
WATER RANUNCULUS. ? SP
PLENTIFUL
AVERAGE DIAMETER 30 FEET
AVG. DEPTH 3 FEET
XY TREES AND SHRUBS
THREE NORTH LONDON PONDS
LUDGROVE + CATHILL + VERNON COW-POND

Observations on Phytoplankton and Microfungi.

The sequence of phytoplankton was studied in the following ponds :—

1. *Vernon Fish-Pond.*

This is an artificial water laid down as a fish and swimming pool; the water is obtained from a well, the contents of which are pumped into the pond at intervals. One side of the pond adjoins the main road, the other three sides are surrounded by meadows. The water is almost entirely screened by shrubs and trees, which give protection from wind; this screen, coupled with the luxuriant growth of Potamogeton and other aquatic plants, maintains a stagnant condition of the water. Its length is 100 feet, width 25 feet, and average depth 4 feet.

We have records of one swarming of *Ceratium hirundinella* and of Volvox, the former being limited to an area of a few square yards at one end of the pond. This swarm of Ceratium continued from July 19 to September 30, 1923. Similar swarms were not found at other parts of the pond. Ceratium slowly distributed itself over the whole pond.

In the meantime we found pockets of Volvox in various parts of the water, and these, by slowly expanding, joined up and produced a characteristic swarming. These pocket formations of algæ have been frequently observed.

2. *Grovelands Pond.*

A few notes from observations made on this pond, 1920–22, are given. In December, 1920, the pond swarmed with *Volvox globator*, which continued to hold the water in varying intensities until the end of April, 1921. Volvox did not reappear until May, 1922, and disappeared by June 18, 1922.

During both periods there was an abundance of water-fleas, *Daphnia magna*, and outbursts of *Brachionus urceolaria* and *B. rubens*, the latter attached to the carapace of water-fleas; also one short swarm, lasting two weeks, of a rather rare rotifer, *Pedalia mira*. In addition, a strong showing of *Botryococcus Braunii* occurred. On July 21, 1922, this alga was in such dense quantities as to colour the water brick-red.

Within an area of two miles our records show the appearance of Volvox in various ponds :—

Vernon Cow-Pond : January, June, July, September to November, 1924; April to July, 1925.

Ludgrove Pond : September to December, 1926; June to July, September to October, 1927.

Grovelands Pond : December, 1920; April, 1921, and May to June, 1922.

Trent Park : May 21, 1922.

Farm Pond, Cock Fosters : December, 1921.

FIG. 3.—SECTION I (*continued on opposite page*).

ANALYSIS OF PHYTOPLANKTON QUANTITIVE RECORDS, SHOWING SWARMING PERIODS, BACILLARIALES AND ISOKONTÆ.

Nov. 1922–Nov. 1925.

JERSEY WATERWORKS.

O. 1922/3 — $\frac{A\ 147}{C\ 4^*}$

DATE.	NO.	TEMP.
6 Nov.	606	—
14 „	1342	—
28 „	110	—
4 Dec.	65	7·2
9 Jan.	—	6·0
21 „	8	6·2
29 „	184	6·3
5 Feb.	160	7·5
11 „	88	7·3
Total	2563	
ASTERIONELLA		

O. 1923 St. — $\frac{A\ 1224}{C\ 20}$

DATE.	NO.	TEMP.	NO.	NO.
Feb. 18	140	7·9	112	1884
„ 27	296	7·7	104	1716
Mar. 9	2116	8·5	444	16
„ 20	2812	8·7	268	12
„ 26	1748	9·3	276	—
Apl. 3	40	11·4	20	4
Total	7152		1224	3632
SYNEDRA			ANKISTRODESMUS	NEPHROCYTIUM

St. 1923 — $\frac{A\ 80}{C\ 29368}$

DATE.	NO.	TEMP.
Apl. 15	44	10·9
„ 30	276	10·6
May 7	596	13·0
„ 13	1856	12·4
„ 20	2708	12·9
„ 27	2280	13·6
June 3	2448	14·1
„ 12	2384	14·8
„ 17	2512	14·8
„ 24	3536	16·3
July 2	3856	17·1
„ 7	4608	18·5
„ 14	2096	19·9
„ 22	32	20·2
„ 29	12	19·8
Aug. 5	—	20·5
„ 12	4	20·5
„ 19	60	20·4
Total	29368	
CŒLASTRUM		

July 5th, 6th, 7th, 9th. Copper sulphate applied

O. 1923 St. — $\frac{A\ 46}{C\ 944}$

DATE.	NO.	TEMP.	NO.	NO.
Aug. 26	76	18·3	424	124
Sept. 2	20	16·2	400	128
„ 9	32	16·1	24	8
„ 16	32	16·9	12	528
„ 23	32	14·6	—	56
„ 30	280	15·1	16	48
Oct. 7	12	12·9	12	20
„ 14	280	14·1	—	32
Total	764		888	944
ASTERIONELLA			CŒLASTRUM	COSMARIUM

O. DINOBRYON.

Aug. 26	132
Sept. 2	408
„ 9	444
„ 16	948
„ 23	576
„ 30	1068
Oct. 7	164
„ 14	24
Total	3764

Great proportion consisted of dead Loricæ due to breaking up of colonies.

O. 1923/4 — $\frac{A\ 3206}{C\ 116}$

DATE.	NO.	TEMP.
Oct. 28	1616	11·4
Nov. 4	2220	11·5
„ 12	3048	8·6
„ 17	3240	8·1
„ 25	3028	6·4
„ 30	1912	5·1
Dec. 7	2168	5·5
„ 15	1004	6·6
„ 21	660	5·9
„ 29	88	7·3
Jan. 5	48	7·3
„ 11	80	6·3
„ 19	148	7·1
Feb. 1	684	7·0
„ 8	1004	7·0
„ 15	2060	6·0
„ 23	3624	5·1
Mar. 2	3744	4·5
„ 8	2840	5·6
„ 15	912	6·7
„ 22	44	6·7
Total	34182	
ASTERIONELLA		

* Total quantities (A) Ankistrodesmus and (C) Cœlastrum only during each period.

Number of Diatoms and Chlorophyceæ per (500) c.c. of water on dates given, also temperature of water Centigrade.

FIG. 3. SECTION I (*concluded.*)

ANALYSIS OF PHYTOPLANKTON QUANTITIVE RECORDS, SHOWING SWARMING PERIODS, BACILLARIALES AND ISOKONTÆ.

NOV. 1922–NOV. 1925.

JERSEY WATERWORKS.

ST. 1924 — A 1512 / C 60

DATE.	NO.	TEMP.
Mar. 22	52	6·7
„ 29	100	9·0
Apl. 5	776	7·5
„ 12	320	8·3
„ 20	84	9·3
„ 26	56	11·1
May 3	16	—
„ 10	44	13·0
„ 17	64	13·7
Total	1512	

ANKISTRODESMUS

Four Months } (see Aug., Sept., Oct., Nov. 1924)

ST. 1924/1925 — A 372 / C 596

DATE.	NO.	TEMP.
May 24	100	14·9
June 14	1228	17·1
„ 21	1752	16·7
„ 28	2264	17·3
July 5	876	18·2
„ 13	756	18·4
„ 19	148	19·0
„ 26	4	19·1
Total	7128	

OOCYSTIS

Copper Sulphate applied: Two doses June, again in Aug. ? also Nov.

1924

AUG., SEPT., OCT., NOV. No Swarming.

Asterionella	200
Cœlastrum	116
Ankistrodesmus	400

All Diatoms Total	All Chloro., Total
648	1424

12 SAMPLES

Dec. 1924 to Jan. 1925 NO RECORDS

O. 1925 — A 464 / C 136

DATE.	NO.	TEMP.
Feb. 17	208	7·8
„ 21	360	7·0
Mar. 18	2464	7·3
„ 21	3224	7·8
„ 29	5448	7·1
Apl. 12	17968	9·5
„ 18	22760	10·5
„ 26	20566	10·5
May 3	20880	11·1
„ 10	28896	11·7
„ 17	35584	12·9
„ 24	2412	14·3
„ 31	252	14·5
June 7	68	15·9
Total	161090	

ASTERIONELLA

ST. 1925 — A 1680 / C 336

DATE.	NO.	TEMP.
June 14	408	17·9
„ 21	476	19·5
„ 28	396	18·4
July 5	376	19·5
„ 12	24	18·9
Total	1680	

ANKISTRODESMUS

ST. 1925 — A 164 / C 3904

DATE.	NO.	TEMP.
July 12	24	18·9
„ 19	32	19·1
Aug. 2	1280	17·9
„ 9	1592	18·1
„ 16	976	19·3
Total	3904	

CŒLASTRUM

O. SYNEDRA

Aug. 23, 30–Oct. 25, 1925

DATE.	NO.	TEMP.
Aug. 16	4	Temp. 19·3
„ 23	2224	„ 19·2
„ 30	1248	„ 17·6
Oct. 25	1092	„ 12·5
Total	4568	

O. 1925 — A 164 / C 512

DATE.	NO.	TEMP.
Sept. 6	1484	17·6
„ 13	7864	15·7
„ 27	14432	13·9
Oct. 4	31184	13·7
„ 11	13024	14·0
„ 25	11816	12·5
Nov. 1	20512	14·4
„ 8	12280	11·5
Total	112596	

ASTERIONELLA

Nov. 8, 1925— RECORDS CEASE.

NOTE.—AT THE HEAD OF EACH COLUMN:
O. = OIL
ST. = STARCH.

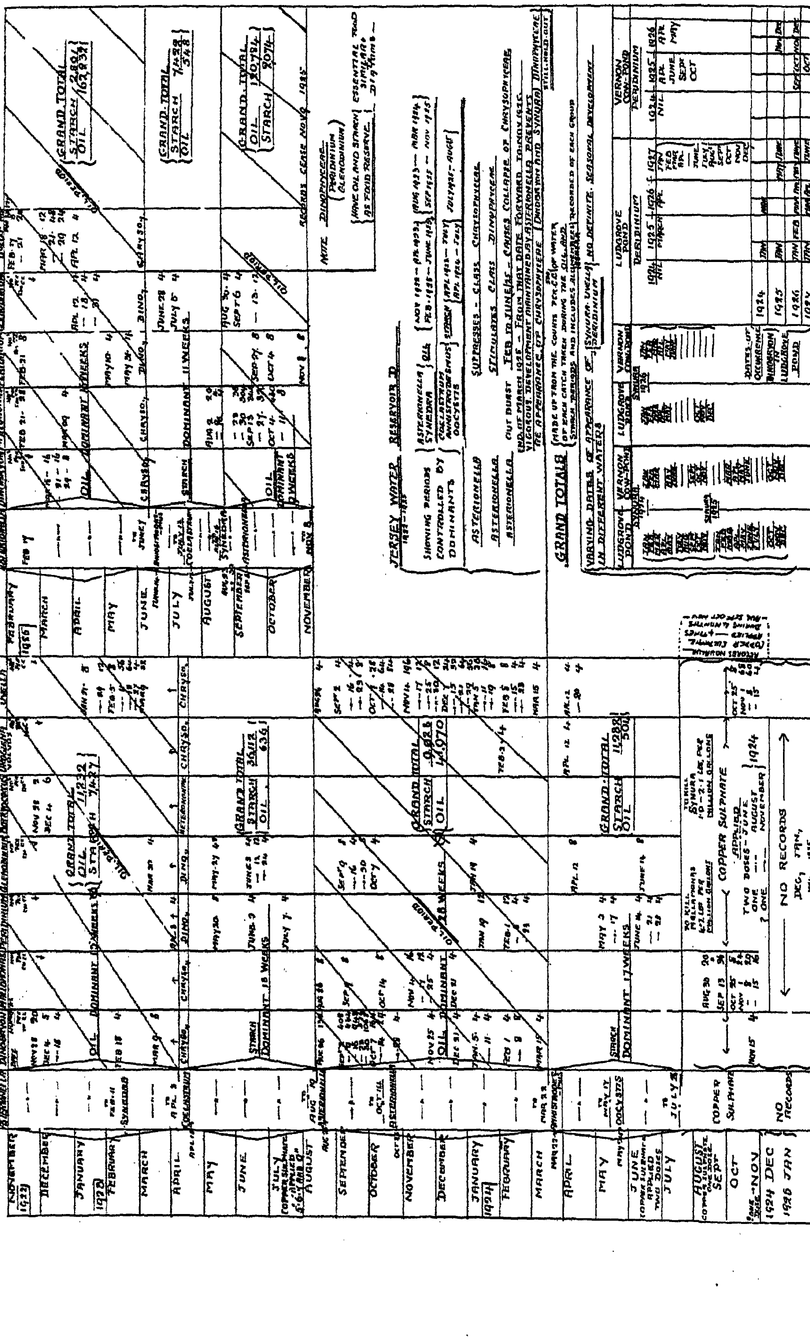


Fig. 4.

Fig. 3.—Workings of dominants and some subdominants only are accounted for. Fig. 4 includes all dominants and suppressed Bacillariales and Isokontæ given in the Jersey records. Alternation of oil and starch periods is still maintained.

3. *Vernon Cow-Pond.*

The water-supply came from ground springs; slight trickling of water at the outlet; pond practically stagnant; two-thirds surrounded by shrubs and trees; average breadth 36 feet; depth, shallow at sides, towards centre 2–3 feet. Limited growth of Potamogeton. Surface for the most part covered with *Lemna minor* and *L. trisulca*. Fish, a few carp.

Two or three cows used the pond for drinking. Moderate drainage from droppings entered the water.

Green algal cells, Zoöxanthellæ, appear to be common associates with Infusorians, Rhizopods and Rotifers. The rotifer *Ascomorpha sultans* Bartsch was frequently in abundance, exhibiting the characteristic symbiotic relationship of a rotifer with an alga, probably Zoöxanthellæ.

4. *Cathill Pond.*

Cathill Pond, about one mile distant from Ludgrove, was visited once only. Time did not permit direct visits, and our samples were taken from an overflow pipe which emptied into a pond on the Vernon estate. Owing to varying water-levels, collecting was not satisfactory. The water just trickled through, and often no samples could be secured. With exception of the addition of recorded swarms of microcystis, the phytoplankton is similar to that of Ludgrove Pond.

One interesting haul was made in November, 1925—*Ochromonas simplex*, a species new to Britain.

5. *Ludgrove Pond.*

Adjoining Hadley Wood (North London). 1924–1927.

An average of thirty-six visits was made for four years, 1924 to 1927. By constant working we became familiar with all aspects of the water, and readily noticed any important changes that took place in the phytoplankton.

As a check, our samples were taken from two sides of the pond, and always from the same two areas. When necessary, additional dips were made to test whether a swarming was local or general; frequently the swarmings were limited and in pockets. No device can overcome the difficulty of irregular distribution, which must vitiate calculations. The plan devised was to concentrate upon small areas and take the averages over long periods from the same regions.

The two tubes from Ludgrove Pond gave similar results, but the samples taken from the west frequently showed more rotifers than those from the east. The phytoplankton and rotifers were, however, fairly mixed. The

value of the eyespot was evident; phototropism kept the two groups, the rotifer and its food, constantly in the same region.

Charts have been plotted giving frequency occurrences in three North London ponds situated within an area of one mile—Ludgrove, Cathill, and Vernon Cow-Pond; incidentally we shall refer to two others—Vernon Fish-Pond and Grovelands.

A few notes of general observations will be of interest. Volvox does not occur in Ludgrove Pond, with the exception of one record, for the two years 1924–25; during 1926–27 it was abundant. In the Cathill Pond, one mile distant, Volvox was also absent during 1924–25, and in abundance for the two years 1926–27. In the adjoining cow-pond in three years' record it occurred in 1924–25, but not in 1926.

Colacium vesiculosum.—One of the smallest algæ, which the text-books register as an epiphyte. This was epizootic and recorded on *Diaptomas castor, Triarthra terminalis,* Brachionus, Anurea and *Polyarthra platyptera.* The rotifers at times were so loaded that only the tips of the cilia were visible. Colacium had a preference, if we might say so, for *Triarthra terminalis.* The Synchætas were rarely "carriers." The Colacium swarmers were in vast numbers, colouring the whole water deep olive-green.

In 1924 they dominated the pond from September 6 to October 25, and from November 1 to 10; the entire surface of the water presented an unbroken iridescent film, the result of quantities of these swarms held by surface tension.

Disease as one of the causes checking the development of some planktonic fauna and flora is interesting, and we have records of species of sporozoa constantly attacking the following rotifers throughout the year—*Polyarthra platyptera,* Synchæta, *Triarthra terminalis, Rhinops vitrea,* Brachionus. These parasites appear to be general; they were also recorded occurring in the rotifera in Cathill Pond.

We have particulars of only one aquatic fungus infecting the phyto-plankton, and we are indebted to Mr. E. H. Ellis, who identified it as a species of Rhizophidium (Chytridiaceæ). This fungus definitely checked *Eudorina elegans.* It was first noticed March, 1927; by the end of April every specimen we took was infected, while Chlamydomonas was free, also Volvox.

In the Cathill Pond, one mile distant, a species of Rhizophidium also attacked Chlamydomonas. *Eudorina elegans* was present, but we did not find any infected, which appears to indicate two species of this fungus, each attacking its own alga.

Diatoms in the Ludgrove Pond were very scanty; this was also noticed in the neighbouring ponds, Cathill and Vernon Cow-Pond.

The dominant macrophyte in Ludgrove was *Nymphea lutea.* This lily covered the pond so effectively that the moorhens could run on its leaves almost from one end to the other. Its submerged leaves are characteristically produced in the winter and spring, and are usually succeeded by floating

leaves appearing in March and April. There are records of this lily flowering without producing any but submerged leaves (Arber (1920[2]). The lilies were scythed and carted each midsummer; the cutting did not kill, but no doubt weakened the growth, partly by bleeding and also by restricting photosynthetic activity. The floating leaves only were affected, the submerged mostly escaping the scythe, having short stalks. Throughout the

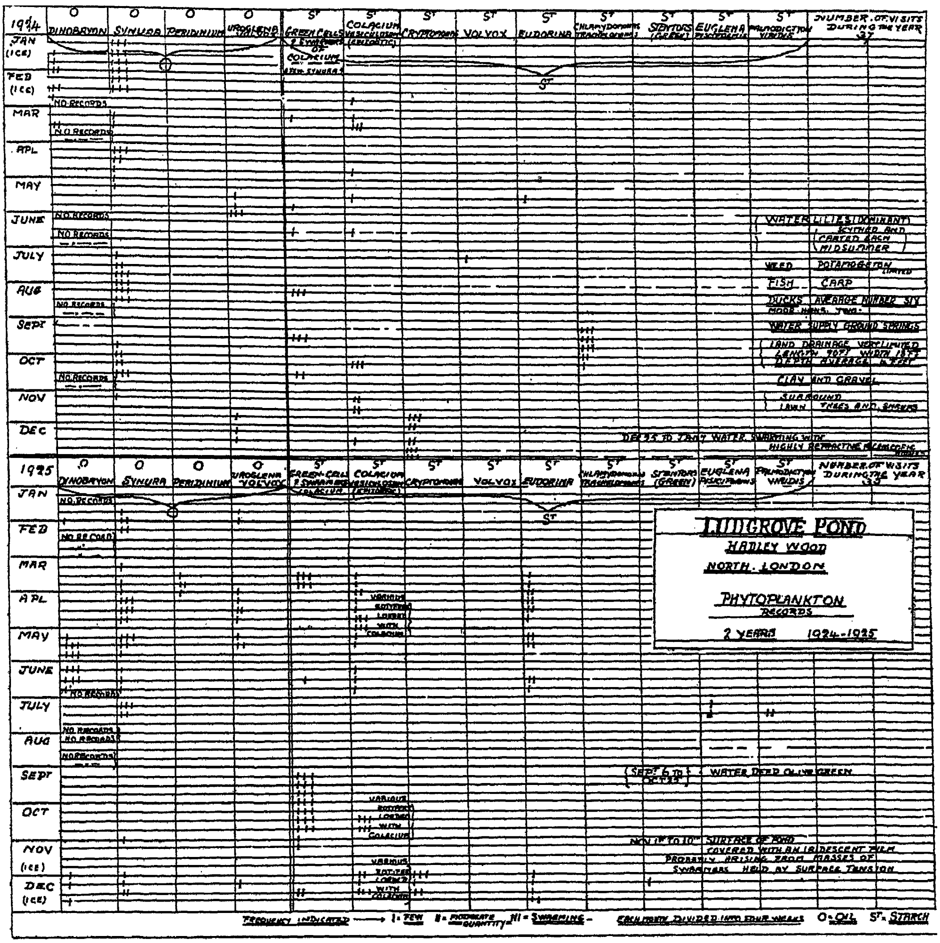


FIG. 5.

year the submerged leaves were in evidence, and the active winter and spring growth no doubt checked the usual increase of carbon dioxide common during those months.

The *p*H, which was taken weekly at the pond side, using 0·1cc. universal indicator to 10 cc. of water, registered 8·5 February 17, 1924, and, with occasional variations between 8·5 to 8·0, until November, 1924. Vernon Cow-Pond during the same period varied between 6·5 and 8·0.

The epiphytes on the filamentous algæ and stems of the lilies were kept in check, on the one hand, by six ducks (mallards) and, on the other, by the scything; this also minimized the volume of richly organic deposits that

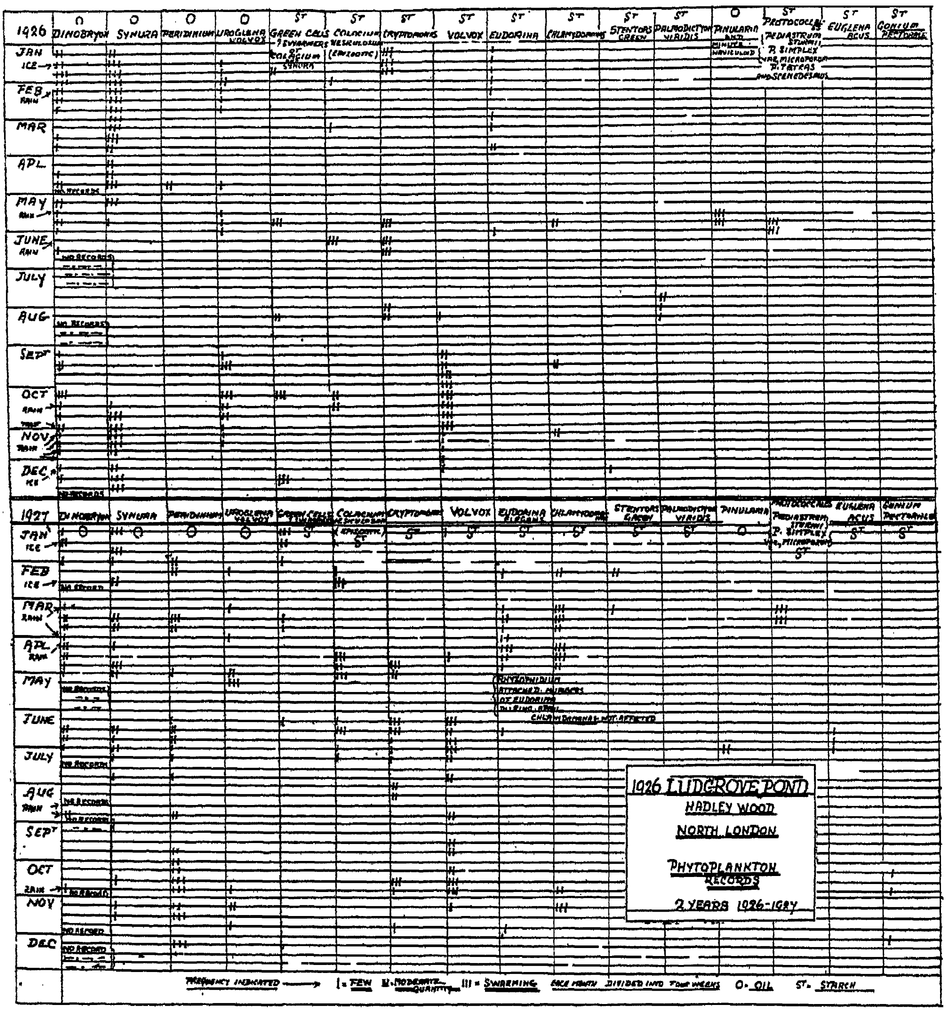


FIG. 6.

would arise from incompletion of decay of such vegetation. A fair quantity of leaves fell into the water from the surrounding trees.

During 1924–25 we were constantly disappointed with the lack of variations and scantiness of species of the algal flora, but they were, comparatively, more interesting in 1926–7. Details of the principal genera are shown on figs. 5 and 6, covering four years, 1924–27.

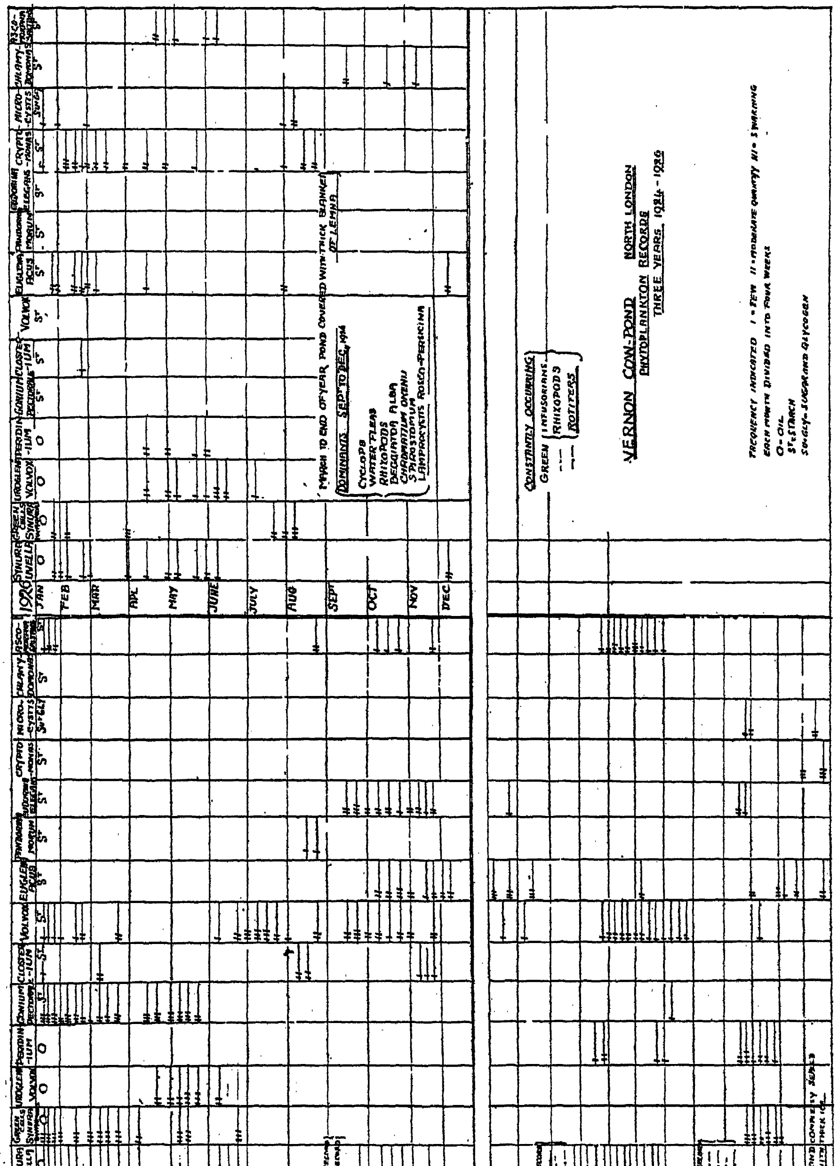

VERNON CON-POND NORTH LONDON
PHYTOPLANKTON RECORDS
THREE YEARS 1924 - 1926
FREQUENCY INDICATED I = FEW II = MODERATE QUANTITY III = SWARMING
EACH MONTH DIVIDED INTO FOUR WEEKS
O = OIL
St = STARCH
SU-GLY = SUGAR AND GLYCOGEN
CONSTANTLY OCCURRING
GREEN INFUSORIANS
RHIZOPODS
ROTIFERS
MARCH TO END OF YEAR POND COVERED WITH THICK BLANKET OF LEMNA
DOMINANTS SEPT TO DEC 1926
CYCLOPS
WATER FLEAS
RHIZOPODS
BEGGIATOA ALBA
CHROMATIUM OKENII
SPIROSTOMUM
LAMPROCYSTIS ROSEO-PERSICINA
1924
1925
1926

FIG. 7.

Jersey Water (Reservoir D), November, 1922–November, 1925.

The gathering ground of the St. Lawrence Stream covers 1,200 acres. Part source of supply is amongst volcanic rocks, chiefly felsites ; bulk supply, drainage from cultivated land. Water-supply passes from St. Lawrence Stream to settling pond, then to Reservoir D, to which our attention has been mainly confined.

The reservoir was formed by damming the valley ; it has a capacity of 33 million gallons and average depth of 25 feet. Depth of outlet pipe in relation to surface, 12 feet. Owing to varying changes of water-level, the average was 5 feet.

Copper sulphate was applied to check algal development on the following dates :—Four doses, July 5, 6, 7 and 9, 1923 ; June to August, and November, 1924. Average suggested dose, 0·1 part by weight per million parts of water.

Long average rainfall, 33 inches per annum.

Dinobryon counts, August–October, 1923, should be modified, as the loricæ were in some cases counted as colonies.

Method of collecting : no net employed.

Samples of about 500 cc. were collected and concentrated to one-fiftieth of the original sample, 500 cc. to 10 cc.

The concentration and enumeration were carried out by the Sedgwick-Rafter method, details of which are given in Whipple's "Microscopy of Drinking Water."

The samples from Reservoir D were taken at the exit of main emptying into and before reaching Reservoir M, usually at 3 p.m.

The St. Lawrence Stream drains a richly-manured area which is also thickly studded with cattle.

The year round, the reservoir is intermittently supplied with highly-charged nitrogenous matter, hence there are no definite periods of slowing down of the planktonic flora frequently witnessed in closed ponds, due to food exhaustion by competition of the macro- and microphytes.

Reservoir D was emptied and cleaned in 1922, and any effects likely to arise from decomposition products of deeply submerged sediment under the action of anærobic bacteria (Whipple (1914[1]) and Griffiths (1923)) would be minimized owing to the water of the reservoir being changed approximately five times during the year. The average daily demand is 500,000 gallons, and the capacity of the reservoir 33 million gallons.

We analysed the phytoplankton records, and some interesting features were disclosed. A very definite rise and fall occurred during the three years between seven genera—two Bacillariales, five Isokontæ—out of thirty-two recorded ; also the increase and decrease of growth did not synchronize exclusively with rising or falling temperatures, or occur only in the winter or summer months.

Growth and Temperature.—We give a selection of the counts per 500 cc. of water, together with water temperatures Centigrade, and dates of occurrence of four of the dominants :—

	Counts.	Water Temperature.
Oct. 28, 1923.—Asterionella	1,616	11·4° C.
Nov. 25, 1923.— „	3,028	6·4° C.
Jan. 11, 1924.—	80	6·3° C.
Mar. 2, 1924.—	3,744	4·5° C.
May 17, 1925.—	35,584	12·9° C.
„ 31, 1925.—	252	14·5° C.
Oct. 4, 1925.—	31,184	13·7° C.
Mar. 20, 1923.—Synedra	2,812	8·7° C.
Apr. 3, 1923.— „	40	11·4° C.
Aug. 23, 1923.— „	2,224	19·2° C.
Apr. 30, 1923.—Cœlastrum	276	10·6° C.
July 7, 1923.— „	4,608	18·5° C.
Aug. 19, 1923.— „	60	20·4° C.
Mar. 22, 1924.—Ankistrodesmus	52	6·7° C.
Apr. 12, 1924.— „	320	8·3° C.
May 10, 1924.— „	44	13·0° C.
June 14, 1925.— „	408	17·9° C.
July 12, 1925.— „	24	18·9° C.

Asterionella exhibits a particularly interesting movement, including two maxima and two minima within the limits of a gradually declining temperature from 11·4° C. to 4·5° C., finishing, on March 22, at 6·7° C. From February 11, 1925, to May it increases on a rising temperature 7·8° C. to 12·9° C.

Algal development proceeds within the limits imposed by rigorous arctic conditions—just above freezing-point (West and West (1911))—and 87° C., the temperature induced in hot springs (West and Fritsch (1927)), quoting Brewer and Weed.

Loch Katrine.

In contradistinction to the Jersey water is that of Loch Katrine. It has an area of about 5 square miles, a scarcity of marginal aquatic vegetation and bottom growth, owing to inhospitable and steeply sloping sides and abnormal depth, reaching at one place to about 500 feet. There is constant dilution by heavy rainfall, the quantity registered by seven gauges round the loch giving an average of 90 inches per annum, compared with Jersey's 33 inches per annum, the loch average increasing at times to 100 inches per annum, causing the water to rise 12 inches in 24 hours. The surround is an uncultivated area.

Here we expect to find scanty microflora, and this is confirmed by the condition of the water on reaching the Glasgow waterworks. It is passed to the consumer without filtration of any kind.

The comparatively sterile condition of the water is not favourable to swarming of algal flora, but there is a definite seasonal bacterial development. Most of the water runs over a well-worn rocky course, carrying little organic substances with it, and is therefore comparable to distilled water.

"The Bathymetrical Survey of Freshwater Lochs of Scotland" gives a list of 150 species of Chlorophyceæ (Isokontæ), which includes 120 desmids obtained in plankton nets, a large portion of which must be casuals washed out from the local peat bogs. Similar closed bodies of deep water subject to constant dilution and not surrounded by cultivated areas should also show an absence of phytoplankton.

Records of the Jersey reservoir show the Bacillariales as dominants. Any attempt, however, to apply a general rule demonstrating a controlling influence of diatoms on all classes of the phytoplankton fails, notably so in the North London ponds, where we have an almost complete absence of a diatom population, the rise and fall of the dominants being carried on by the Chrysophyceæ and Dinophyceæ associated with the Isokontæ.

The problem of finding a solution of the causes maintaining rotation of two or more genera, or the sudden increase in numbers or swarming of a dominant, was at first baffling.

Division of the Phytoplankton into Two Main Groups.

At this point we decided to discard genera as a means of differentiation and employ a simpler plan—that of taking food reserves of the various classes of the phytoplankton, roughly starch and oil, and ascertaining what relationship might exist between these two groups.

As a guide to the grouping we prepared a key in which most of the genera transferred from our records appear under their respective classes.

So far as the total genera of each class is concerned, the key is incomplete, but additions can be made as occasion demands. The classes are in accordance with West and Fritsch ("Freshwater Algæ," 1927).

Eight genera named in the key, claimed by both algologists and protozoologists, have been included as algæ. In addition, green infusorians and rotifers exhibiting a "symbiotic" relationship, probably with Zooxanthellæ, have also been included, as they function in a similar manner to green algæ.

The food reserve of the Myxophyceæ (sugar, glycogen and minute drops of oil) indicates that this class may possibly prove to be variable.

After reviewing our records, rearranged in accordance with the classes shown in the key, we were able to equate a few conspicuous factors and correlate others. We were, therefore, prompted to put forward a tentative hypothesis, and in the following pages demonstrate its working and results when applied to various waters where we have data of sufficient precision.

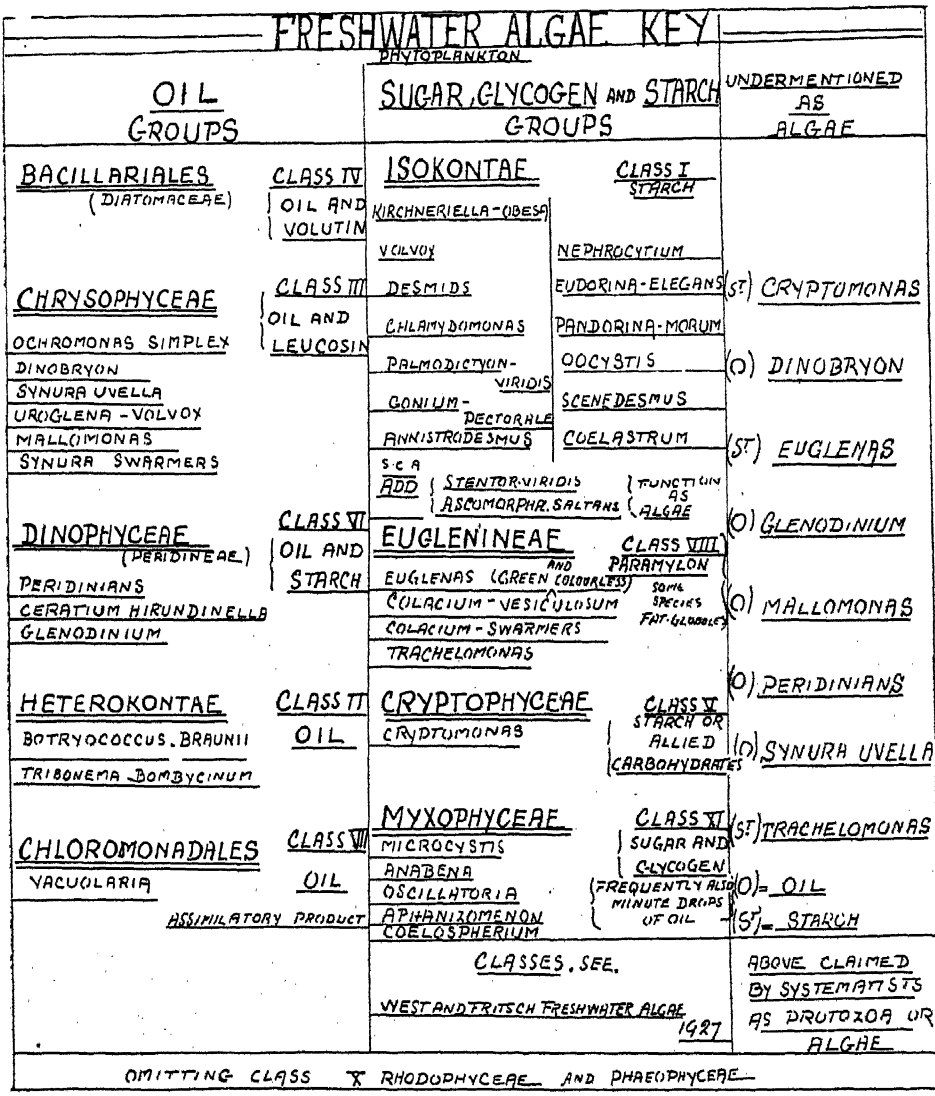

FRESHWATER ALGAE KEY
PHYTOPLANKTON
OIL GROUPS
SUGAR, GLYCOGEN AND STARCH GROUPS
UNDERMENTIONED AS ALGAE
BACILLARIALES (DIATOMACEAE)
CLASS IV
OIL AND VOLUTIN
ISOKONTAE
CLASS I STARCH
KIRCHNERIELLA-OBESA
VOLVOX
NEPHROCYTIUM
CHRYSOPHYCEAE
CLASS III
OIL AND LEUCOSIN
DESMIDS
EUDORINA-ELEGANS
(ST) CRYPTOMONAS
OCHROMONAS SIMPLEX
CHLAMYDOMONAS
PANDORINA-MORUM
DINOBRYON
PALMODICTYON-VIRIDIS
OOCYSTIS
(O) DINOBRYON
SYNURA UVELLA
GONIUM-PECTORALE
SCENEDESMUS
UROGLENA-VOLVOX
MALLOMONAS
ANKISTRODESMUS
COELASTRUM
(ST) EUGLENAS
SYNURA SWARMERS
S.C.A. ADD
STENTOR-VIRIDIS
ASCOMORPHA. SALTANS
FUNCTION AS ALGAE
DINOPHYCEAE (PERIDINEAE)
CLASS VI
OIL AND STARCH
EUGLENINEAE
CLASS VIII
PARAMYLON
(O) GLENODINIUM
PERIDINIANS
EUGLENAS (GREEN AND COLOURLESS)
SOME SPECIES FAT-GLOBULES
CERATIUM HIRUNDINELLA
COLACIUM-VESICULOSUM
(O) MALLOMONAS
GLENODINIUM
COLACIUM-SWARMERS
TRACHELOMONAS
(O) PERIDINIANS
HETEROKONTAE
CLASS II
OIL
CRYPTOPHYCEAE
CLASS V
STARCH OR ALLIED CARBOHYDRATES
BOTRYOCOCCUS. BRAUNII
CRYPTOMONAS
(O) SYNURA UVELLA
TRIBONEMA BOMBYCINUM
MYXOPHYCEAE
CLASS XI
SUGAR AND GLYCOGEN
(ST) TRACHELOMONAS
CHLOROMONADALES
CLASS VII
OIL
MICROCYSTIS
ANABENA
VACUOLARIA
OSCILLATORIA
FREQUENTLY ALSO MINUTE DROPS OF OIL
(O) = OIL
ASSIMILATORY PRODUCT
APHANIZOMENON
COELOSPHERIUM
(ST) = STARCH
CLASSES. SEE.
WEST AND FRITSCH FRESHWATER ALGAE 1927
ABOVE CLAIMED BY SYSTEMATISTS AS PROTOZOA OR ALGAE
OMITTING CLASS X RHODOPHYCEAE AND PHAEOPHYCEAE

FIG. 8.

Tentative Hypothesis.

1. *Concerning Swarming of Phytoplankton.*

Effect of Toxins (Excretion Products).

1.	Oil Group Class A Genus A 1	Toxin	.. inhibits own growth	Oil Group Class A Genus A 1.
2.	Oil Group Class A Genus A 1	Toxin	.. stimulates growth of another genus	Oil Group Class A Genus A 2.
3.	Oil Group Class A Genus A 1	Toxin	.. stimulates growth of some genera of another oil class	Class B.
4.	Oil Group Class A Genus A 1	Toxin	.. inhibits growth of some genera of another oil class	Class C.
5	Oil Group Classes A, B, C	Toxins	.. are accessory foods of the	Classes D, E, F (Starch Group).

Restated.

1.	Asterionella	..	.. inhibits (own growth)	Asterionella.
2.	Asterionella	..	.. stimulates growth of, say	Synedra.
3.	Asterionella	..	.. stimulates growth of some genera of	Oil Class Dinophyceæ.
4.	Asterionella	..	.. inhibits growth of some genera of ..	Oil Class Chrysophyceæ.
5.	Bacillariales Chrysophyceæ Dinophyceæ Oil Group	Toxins	Are accessory foods of the	Starch Groups, Details, *see* key, fig. 8.

2. Inhibition and stimulation between classes and genera of the oil groups are repeated in the starch groups.

3. *As Accessory Food.*

Excretion products from the oil classes (Bacillariales, Chrysophyceæ, Dinophyceæ, Heterokontæ, Chloromonadales) become accessory foods for the starch classes, and the excretion products of the starch classes (Isokontæ, Euglenineæ, Cryptophyceæ, Myxophyceæ) become accessory foods for the oil classes.

4. *Limiting Factor.*

Competition for essential foods, as distinct from accessory foods, by the dominant suppresses the less aggressive genera of the same class.

5. *Effects of Still and Moving Water.*

The unidentified chemical accessory foods are easily oxidized, which process is variable in fast, moderately moving, or still waters. These varying movements of the water affect oxidation and govern the volume of swarming of the phytoplankton.

6. Substantially, we found when genera of the class Bacillariales (oil) were absent or not dominant, the genera of the two classes Chrysophyceæ and Dinophyceæ (oil) appear and function as oil dominants.

The genera of either of these three classes will pair off and work with the genera of the Isokontæ (starch), or, failing this, then with genera of the class Myxophyceæ.

We have no records of the Chrysophyceæ and Dinophyceæ (oil) pairing exclusively with Myxophyceæ (starch).

The classes Heterokontæ, Chloromonadales, Eugleninеæ, Cryptophyceæ, we make no special reference to, as these four classes do not enter very largely into our calculations.

The Freshwater Algæ Grouped According to Food Reserves, Oil and Starch.

The results indicate an association between the two in the following waters :—Grovelands Pond, Lake Cochituate (Boston, U.S.A.), Jersey Reservoir, Ludgrove Pond.

We turned back to records of 1920, and at once saw a meaning in the occurrence of *Botryococcus Braunii* (oil) with Volvox (starch) in Grovelands Pond, and again in the association of *Ceratium hirundinella* (oil) with Volvox (starch) in Vernon Fish-Pond.

Again, in Lake Cochituate, Whipple (1914) claims the regular occurrence of Myxophyceæ and Bacillariales during the five years 1901 to 1905 as seasonal development.

We suggest a more interesting interpretation of this phenomenon. Normally, spring is the period for usual maximum development of diatoms, light being one of the factors of supreme importance in plant growth. In this water the maximum development of diatoms is consistent during the winter ; moreover, it is always preceded by the Myxophyceæ. There is no change-over in the sequence, a maximum growth of diatoms preceding the Myxophyceæ. This orderly and consistent occurrence of classes over a period of five years—first the Myxophyceæ, followed by a maximum growth of the Bacillariales—indicates the effects of accessory foods (excretion products) of the Myxophycean flora, compelling a winter maximum of the diatoms.

There is a moderate showing of spring diatoms working in conjunction with the spring Chlorophyceæ (Isokontæ). The latter are not shown on the chart, food shortage being a limiting factor of spring growth due to the vigorous development of phytoplankton during the previous autumn and winter.

The Jersey reservoir also exhibits a succession of genera between the Isokontæ (starch) and Bacillariales (oil) (fig. 3).

The Ludgrove Pond, however, shows an association mainly between three classes—Chrysophyceæ (oil) and Dinophyceæ (oil) and Isokontæ (starch), with Volvocales on the whole as the starch dominant, 1926–27 (figs. 5, 6).

A further examination of the analysis of the Jersey reservoir record reveals an intimate working together of the oil and starch groups. In this water 10 genera of diatoms are recorded, and 22 of the Isokontæ. Two genera only of the diatoms are dominants, Asterionella and Synedra (oil), together swarming 67 weeks out of the total records of three years. Cœlastrum and Ankistrodesmus are dominants in the starch group, together covering 40 weeks, and these were joined by Cosmarium, Nephrocytium, and Oocystis, together covering 14 weeks, making a total for the starch group of 54 weeks against 67 weeks oil.

The sequence of the two groups for three years is as follows (fig. 3):—

Oil. Asterionella, Synedra ..	19 weeks ..	November 6, 1922, to April 3, 1923.
	Starch. 6 weeks ..	Moderate swarm of starch Ankistrodesmus. Nephrocytium runs concurrently from February 18 to April 3. A temporary disturbance in the oil and starch balance occurred February 18 to 27, due to a sudden outburst of Nephrocytium.
Starch. Cœlastrum ..	20 weeks ..	April 3, 1923, to August 19, 1923.
Oil. Asterionella ..	7 weeks ..	August 26, 1923, to October 14, 1923.
	Starch. 7 weeks ..	Copper sulphate applied, 4 doses, July 5, 6, 7 and 9, checked most phytoplankton. A moderate swarm of starch Cosmarium and Cœlastrum runs concurrently from April 26 to October 14.
Oil. Asterionella ..	21 weeks ..	October 28, 1923, to March 22, 1924.
Starch. Ankistrodesmus, Oocystis.	17 weeks ..	March 22, 1924, to July 26, 1924.
	6 months No records ..	Sulphate copper applied June, August, November, spoiled records four months August to November, 1924. Two months, December, 1924, and January, 1925, no records.
Oil. Asterionella ..	16 weeks ..	February 17, 1925, to June 7, 1925.
Starch. Ankistrodesmus, Cœlastrum	11 weeks ..	June 14, 1925, to August 16, 1925.
Oil. Asterionella, Synedra ..	9 weeks ..	August 23, 1925, to November 8, 1925.

Records cease November 8, 1925.

The action of the two groups for three years presented a rotation mainly between three dominant genera, two starch (Cœlastrum, Ankistrodesmus), and one oil (Asterionella)—a phenomenon of extraordinary interest.

Inhibition and Stimulation of Growth by the Oil Dominant Asterionella.

Another interesting point presents itself. Do the suppressed genera of the oil groups confine their restricted activities within the limits of the dominant oil periods?

Our chart (fig. 4) demonstrates that substantially this happens. Dinobryon, Mallomonas, Peridinium, Glenodinium, Botryococcus, Uroglena, and Synura were active during this period.

The growth of almost the entire group ceases at the same time that minimum development is reached of the dominant diatom Asterionella.

Diatoms are dominant during the oil periods, with Dinobryon and Synura comparatively strongly represented, except the period dated August 19, 1925, to November, when both disappear (*see* fig. 4).

The Dinophyceæ (Peridinium and Glenodinium) feel the competition of Asterionella, the essential food of both diatoms and Dinophyceæ being similar (Johnstone, Scott and Chadwick (1924)).

At the cessation of the oil period the stimulating effect of diatom toxin on Peridinium has little influence. In all the "follow-on" starch periods we find the Dinophyceans just surviving, but unable to develop.

In other waters, Milwaukee (Wimmer) and ocean records (Herdman), where essential foods are not exhausted, we have an immediate rise of Dinophyceæ on a sharp fall of the diatoms.

It is interesting to observe the effect of diatom toxin on the two classes Dinophyceæ and Chrysophyceæ; the latter does not increase, but appears to be checked, definitely so during the first three oil periods, and during the last two there is a maximum outburst of Asterionella, when both Dinobryon and Synura (Chrysophyceæ) are checked by March 30, 1925, and do not reappear again, the Asterionella maximum continuing until November, 1925, when our records cease.

We witness no recovery of the oil group until the starch period has passed through its phase; this immediately follows on the minimum development of the oil group activities. Rise and decline succeed one another between the oil and starch groups, a sequence which is maintained with striking regularity through three years, exhibiting alternations of four oil and three starch periods.

It might be claimed that as Dinobryon, Synura and Peridinium occur during the winter months, they exhibit normal seasonal development. We, however, obtain no confirmation of this. On the other hand, if we examine the occurrence of these genera in the Ludgrove and Vernon Ponds, which are free of diatom influence, we find all three genera occurring at all times, and we give the dates of occurrence on the chart fig. 4.

Sulphate of Copper Suppresses the Oil Dominant Asterionella and the Starch Dominant Cœlastrum. Immediate Development of Dinobryon and Cosmarium Follows.

We attach considerable importance to the outbreak of Dinobryon, which occurred concurrently with a weak display of Asterionella, August 26 to October 14, 1923, due to the diatom being artificially suppressed (sulphate of copper), permitting Dinobryon to assert itself, indicating that its quiescence is not due to the make-up of the water being a limiting factor to its growth, but to the dominance of the diatom Asterionella. This, when checked, removes the cause of inhibition, and Dinobryon becomes active (fig. 3, August 26–October 14, 1923).

A similar action takes place between the starch dominant Cœlastrum and Cosmarium on the same date, and due to the same cause, viz., suppression of the dominant Cœlastrum by sulphate of copper, resulting in the immediate appearance of Cosmarium. Neither appear again during the unexpired portion of the three years, which is significant. Both Asterionella and Cœlastrum succumb to comparatively weak doses of copper sulphate, which would not affect either Dinobryon or Cosmarium (Whipple (1927)).

We have indicated the peculiar interaction between the eight genera of the oil groups figuring on chart 4, and our interpretation of these actions is as follows:

1.	Asterionella toxin checks Asterionella	This same toxin inhibits growth of Chrysophyceæ	Dinobryon and Synura.
2.	Asterionella toxin checks Asterionella	This same toxin stimulates growth of Dinophyceæ	Peridinium and Glenodinium.
3.	Asterionella and Dinophyceæ have similar essential foods	The dominant Asterionella competes and exhausts some of the elements of essential oil foods, hence feeble response of Dinophyceæ to the toxin of Asterionella when the latter declines	Dinophyceæ exhibit feeble existence and do not rise when Asterionella declines.

An example of quiescence of class Dinophyceæ during domination of diatoms is shown in graph of North Milwaukee Pool (Wimmer (1929)). The essential foods of these two classes being similar, they should show maximum development during the same periods, but this does not occur. The autotoxin of the diatoms ultimately reaches a degree of intensity inhibiting own growth. Not until then is this sufficiently virulent to act as a stimulant to the Dinophyceæ, and they show no definite increase until this happens; we then witness a sharp decline of one and an immediate rise of the other. This peculiar relationship between the two classes is maintained in both marine and freshwater forms, an immediate fall of diatoms commencing June, 1927, reaching a minimum record for the year during July and August (Milwaukee). In June from a minimum record Ceratium

RECORDS OF VARIOUS WATERS WITH DIGEST OF AVERAGE PHYTOPLANKTON.

COUNTRY OR DISTRICT	No.	OIL GROUP	STARCH GROUP	NOTES	AUTHORS
STADDON RESERVOIR Nr PLYMOUTH ONE YEAR	1	D/ MYXOPHYCEAE MICROCYSTIS ?AS-A VARIABLE (SEE ALSO No 8) S/D HETEROKONTAE TRIBONEMA BOMBYCINA BACILLARIALES	ISOKONTAE D/ PROTOCOCCALES SPIROGYRA EUGLENINEAE	NO DIN, OR CHRY, DIATOMS AS EPIPHYTES ON SPIROGYRA ALSO FREE ALSO ALGAE ON CEMENT WALLS	ATKINS AND HARRIS 1924
QUARRY POND. CORNWALL ONE YEAR	2	D/ BACILLARIALES AND DINOPHYCEAE	ISOKONTAE AND EUGLENINEAE	WITH DIN, ONLY NO. EXHAUSTIVE HELEOPLANKTON LIST	
ABBOT'S POOL Nr BRISTOL FIVE YEARS 1904–8	3	D/ BACILLARIALES	ISOKONTAE	NO DIN, OR CHRY, DURING FIVE YEARS	FRITSCH AND RICH 1909
JERSEY ENGLISH CHANNEL ISLANDS THREE YEARS 1923–5	4	D/ BACILLARIALES D/ ASTERIONELLA S/D SYNEDRA	ISOKONTAE D/ COELASTRUM S/S OOCYSTIS NEPHROCYTIUM S/D ANKISTRODESMUS · COSMARIUM	CHRY, AND. DIN,	AUBIN. A.A ? 1925
LAKE COCHITUATE. Nr BOSTON U.S.A FIVE YEARS. 1901–5	5	D/ BACILLARIALES MELOSIRA · TABELLARIA ASTERIONELLA CHRYSOPHYCEAE UROGLENA SYNURA	D/ MYXOPHYCEAE ANABAENA APHANIZOMENON CLATHROCYSTIS COELOSPHERIUM MICROCYSTIS	CHRY., ONLY CHLOROPHYCEAE (ISOKONTAE) POOR	WHIPPLE G.C 1914 PHYTOPLANKTON DETAILS PER WHIPPLE M.C
		PRINCIPAL GENERA FOR 5 YEARS: 1901: MELOSIRA, ASTERIONELLA, UROGLENA, SYNURA — CLASS → MYXOPHYCEAE 1902: MELOSIRA, ASTERIONELLA — MYXOPHYCEAE 1903: MEL[illegible]A — MYXOPHYCEAE	1904: MELOSIRA, TABELLARIA — MYXOPHYCEAE 1905: TABELLARIA, MELOSIRA, UROGLENA — MYXOPHYCEAE		
THREE NORTH LONDON PONDS VERNON COW POND THREE YEARS 1924–6	6	D/ CHRYSOPHYCEAE SYNURA UROGLENA DINOBRYON	ISOKONTAE D/ VOLVOCALES 1924–5	CHRY AND DIN, DIATOMS SCANTY	AKEHURST. S.C 1924–7
LUDGROVE POND FOUR YEARS 1924–7	7	D/ CHRYSOPHYCEAE SYNURA DINOBRYON PERIDINIUM — DINOPHYCEAE	ISOKONTAE COLACIUM AND SWARMERS ALSO VOLVOCALES	CHRY – DIN, DIATOMS SCANTY	— „ —
CATHILL POND FOUR. YEARS 1924–7	8	CHRYSOPHYCEAE SYNURA DINOPHYCEAE PERIDINIUM MYXO? MICROCYSTIS 1924? AS-A VARIABLE (SEE ALSO No 1)	ISOKONTAE	CHRY AND DIN DIATOMS SCANTY GREEN CELLS ? SHOULD BE TREATED AS "OIL"	— „ —
		ONE DAY OR SHORT PERIOD RECORDS			
KRAKATAU. IS, SUNDA STRAIT 1886	9	BACILLARIALES (1897 VISIT) NAVICULA NITZSCHIA ENCYONEMA CYSTOPLEURA	MYXOPHYCEAE (1886 VISIT) LYNGBYA ANABAENA SYMPLOCA TOLYPOTHRIX		ERNST. A 1908
HOT SPRINGS	10	BACILLARIALES	MYXOPHYCEAE		FRITSCH AND WEST 1927
CRYOPLANKTON ALGAL FLORA ON PERPETUAL ICE AND SNOW	11	BACILLARIALES	ISOKONTAE CHLAMYDOMONAS NIVALIS		WEST G.S 1916
ANTARCTIC SHACKLETON EXPEDITION 1907–9	12	BACILLARIALES NAVICULA MUTICOPSIS AND OTHERS WITH	ISOKONTAE PRASIOLA – CRISPA — TWO STAGES & ULOTHRIX IMPLEXA PLEUROCOCCUS AND MYXOPHYCEAE	ON GROUND AND ATTACHED TO STONES NO DIN, OR CHRY –	WEST. W AND WEST. G.S 1911
GROVELANDS POND 1920–22 LONDON. (NORTH)	13	HETEROKONTAE BOTRYOCOCCUS	ISOKONTAE VOLVOX	NO DIATOMS	AKEHURST. S.C 1920–2.
VERNON FISH-POND LONDON · NORTH	14	DINOPHYCEAE CERATIUM - HIRUNDINELLA	ISOKONTAE VOLVOX		— „ — 1924
HYTHE CANAL KENT FILM ON MUD BANKS 1930	15	BACILLARIALES	MYXOPHYCEAE OSCILLATORIA ISOKONTAE DESMIDS. Sp		AKEHURST S.C 1930
NORFOLK BROADS ALSO RIVERS YARE – BURE AUG.st 1924 WROXHAM BROAD UPPER SALHOUSE. Bd SURLINGHAM. Bd ROCKLAND. Bd ORMESBY. Bd	16	D/ BACILLARIALES ORMESBY BROAD BACILLARIALES AND DINOPHYCEAE	ISOKONTAE PROTOCOCCALES	THREE RECORDS ONLY DIN, CHRY MYXOPHYCEAE SCANTY EXCEPT ORMESBY BROAD ! AS DOMINANT	GRIFFITHS. B.M 1926
DULMERSHE POOLS NORTH & SOUTH WHITEKNIGHTS POOL BERKSHIRE 1923	17	ALL THREE POOLS DINOPHYCEAE CERATIUM HIRUNDINELLA	ISOKONTAE ? ? GENERA ALGAE. 3 or 4 SPECIES OCCURRING IN ALL THREE		GRIFFITHS. B.M 1923
FRESH WATER LOCHS OF SCOTLAND	18	CHRYSOPHYCEAE DINOBRYON MALLOMONAS DINOPHYCEAE CERATIUM – HIRUNDINELLA	ISOKONTAE DESMIDS VOLVOX MYXOPHYCEAE ANABAENA CLATHROCYSTIS OSCILLATORIA	DIATOMS POOR	MURRAY. J. AND PULLAR. L
FINGER LAKES OF NEW YORK U.S.A CANANDAIGUA LAKE JULY 1918	19	D/ BACILLARIALES CHRYSOPHYCEAE	CRYPTOPHYCEAE ISOKONTAE D/ MYXOPHYCEAE	TOTAL RECORDS UP TO AND INCLUDING 20 METRES – ONLY – HAULS MADE IN 5. 10. 15. 20/M STRATA	BIRGE. A AND JUDAY. C
CAYUGA LAKE JULY 1918	20	D/ BACILLARIALES	CRYPTOPHYCEAE D/ MYXOPHYCEAE ISOKONTAE	EACH NET PLANKTON HAUL CUBIC METER OF WATER IN CLOSING NET	1914–20 — „ —
SENECA LAKE AUG 1918	21	D/ BACILLARIALES	CRYPTOPHYCEAE D/ MYXOPHYCEAE ISOKONTAE	NANNO PLANKTON OBTAINED BY MEANS OF WATER BOTTLE + CENTRIFUGED	— „ —
		#19 · 20 · 21 STEPHANODISCUS AND APHANOCAPSA DOMINANTS			
GREEN LAKE WIS. U.S.A AUG 1918	22	BACILLARIALES D/ SYNEDRA S/D STEPHANODISCUS	MYXOPHYCEAE D/ APHANOCAPSA	COLLECTIONS MADE AS #19/21	— „ —
SOIL ALGAL FLORA	23	BACILLARIALES	MYXOPHYCEAE CHLOROPHYCEAE	ASSOCIATION – NOT KNOWN	RUSSELL. E. J. 1927

DIN = DINOPHYCEAE. CHRY = CHRYSOPHYCEAE. D = DOMINANT S/D = SUB-DOMINANT. NUMBERS IN BRACKETS SEE REFERENCES.

10 GROUPS DIATOMS DOMINANT # 3. 4. 11. 12. 20. 21 # 16. 9. 10. 22.

THREE GROUPS DIATOMS DOMINANT WITH ANOTHER OIL CLASS (DIN OR CHRY) AS SUB-DOMINANT #2. 19. 5

#7. 15 TWO GROUPS DIATOMS POSITION UNCERTAIN

8. 18. 13. 6. 7. 14. 17 SEVEN GROUPS DIATOMS NOT RECORDED DOMINANT

FIG. 9.

and Peridinium show an immediate rise, reaching a maximum record for the year during July and August (Ceratium 65,000, Peridinium 2,000 per litre of water). Ceratium and Peridinium drop again to a minimum by October, and remain a negligible quantity to the end of the year, whilst the diatoms assume by October, and remain to the end of the year, dominants.

Herdman (1923) states that the ocean diatom maximum of Port Erin Bay occurred March, 1907, April, 1909, May, 1908, showing a difference of two months in the occurrence of the maximum of 1907 and 1908; yet in each of these three years, and including 1912 according to his graph, the Dinoflagellates (Dinophyceæ) occur about one month later than the diatom maximum. The rise of the Dinophyceæ does not occur until a definite and sharp decline of the diatoms is registered. It is interesting to observe that the Dinophyceæ follow the diatoms, and this sequence is not reversed.

Our review of the various records gives strong evidence that in nature Myxophyceæ precede the Bacillariales, and the Dinophyceæ follow.

Milwaukee	Myxophyceæ precede Bacillariales.
Krakatau (Ernst (1908))	
Lake Cochituate ..	
Port Erin Bay	Dinophyceæ follow the Bacillariales.
Milwaukee	

The records on fig. 9 show that the Bacillariales are always associated with one of the starches, which invites the question: Could the diatoms exist and develop unless in association with either the green or blue algæ, fixed or free forms?

We have demonstrated interaction, inhibition, and stimulation between two oils of different classes, Bacillariales and Dinophyceæ, and after a somewhat rigid scrutiny of the three years' records of the Jersey reservoir we located a similar interaction between two starches (Isokontæ), Ankistrodesmus and Cœlastrum. The rise and fall during the three years is shown on fig. 3.

INHIBITION BETWEEN THE GENERA CONSTITUTING THE GROUP VOLVOCALES (STARCH).

In the group volvocales we have an orderly progression from Chlamydomonas to Volvox, showing increasing complexity in the various colonial forms, together with a gradually increasing sexual differentiation of the gametes, yet the primitive chlamydomonadine type of cell is preserved in all the genera constituting the group Volvocales.

The relationship, especially the order of succession of the genera as they appear in all three ponds—Vernon Cow-Pond, Cathill, and Ludgrove—is striking, and, with the exception of Pleodorina, we have a complete series—Chlamydomonas, Gonium, Pandorina, Eudorina, Volvox.

The point to observe is that all of them do not appear at the same period. Only one or, perhaps, two genera at one period, and in Vernon Cow-Pond we have recorded Gonium, Pandorina, Eudorina, Volvox.

In Ludgrove Pond: Chlamydomonas, Eudorina, Volvox.

In Cathill Pond: Chlamydomonas, Eudorina, Volvox.

Recalling the conditions of working these ponds—that is, within a limited area of a few yards, coupled with the habit of pocket formations of the phytoplankton, it is conceivable that some of the missed genera were in existence and we failed to locate them.

Have we here an intricate balancing of the Volvocales due to toxic effects by inhibition and stimulation of growth between genera of this starch group? It would appear so, definitely between Eudorina and Volvox, as they consistently follow one another in the three ponds. We give the order of appearance in three ponds.

Fig. 10.

VOLVOCALES, SUCCESSION.

In Three Ponds.

Gon. 5 months 1924	Vol. 8 months 1924	Pan. 1 month 1924	Eud. 3 months 1924	Vol. 7 months 1925	Eud. 2 months 1925	Vernon Cow-Pond, 1924-5
Chlam. 2 months 1924	Eud. 9 months 1925	Vol. 4 months 1926	Eud. 2 months 1927	Vol. 5 months 1927	Chlam. 5 months 1927	Ludgrove Pond, 1924–7
Eud. 4 months 1924	Chlam. 1 month 1924	Eud. 7 months 1925–6	Vol. 5 months 1926	Eud. 3 months 1927	Vol. 2 months 1927	Cathill Pond, 1924–7

Chlam., Chlamydomonas. *Pan.*, Pandorina. *Gon.*, Gonium, Pectorale.
Eud., Eudorina. *Vol.*, Volvox.

According to the text-books, the evolution of the genera constituting the Volvocales appear in the following order:—Chlamydomonas, Gonium, Pandorina, Eudorina, Pleodorina Volvox, and this is roughly the order our records indicate they appear in the three North London ponds. Associated with these are the oil dominants class Chrysophyceæ.

This curiously parallels the phenomenon of the order of evolution and appearance in nature to-day of the three classes already referred to:—Myxophyceæ, first; Bacillariales, second; Dinophyceæ, third.

Without desiring to push the suggestion of toxic effects too far, there is evidence in these successions of inhibition and stimulation proceeding between genera of both the starch and oil groups.

Inhibition and its Controlling Influence on the Dominants.

The result of inhibition or self-suppression prevents the dominants succeeding to attain universal domination. That such a state would rapidly arise, failing self-suppression, can be appreciated by the supreme position reached by the dominants during comparatively short periods of maximum development indicated by the following figures:—

Jersey Reservoir (32 Genera).

Record.	Total Diatoms and Isokontæ.	Dominant Claims.	Residue.	Total Number of Genera Sharing Residue.	Average Quantity of Each.
6 weeks ..	14·328	12·368	1,968	31	63
18 weeks ..	36·482	29·368	7,114	31	230

Lake Canandaigua, New York, U.S.A. (Birge and Juday (1919)).

One-day haul per cubic metre of water at each 4 levels: 15, 30, 45, 60 feet:—

		Total Millions	Dominant Stephanodiscus Claims Millions	Residue Millions
Oil Group.				
Bacillariales	Stephanodiscus, Synedra, Navicula			
Chrysophyceæ	Synura			
		259	217	42

		Total Millions	Dominant Aphanocapsa Claims Millions	Residue Millions
Starch Group.				
Cryptophyceæ	Cryptomonas			
Isokontæ	Scenedesmus			
Myxophyceæ	Aphanocapsa			
		853	760	93

Inhibition of the dominants prevents reversion to a few archaic dominant types and their ultimate supremacy. In other words, algal development, with its increasing variation of species, can go forward, but inhibition or self-suppression of the dominants prevents a going backward.

Inhibition and stimulation of growth and the effects of accessory foods have to a large extent been demonstrated experimentally:—

1. Bacteria.—J. C. Broom (1929). Inhibition due to the exhaustion of media in bacterial culture.
2. Infusoria.—Woodruff, quoted by Calkins (1926), between two organisms, *Paramecium aurelia* and *Stylonychia pustulata*, reduction and stimulation of vitality, due to excretion products.
3. Diatoms.—E. J. Allen (1922). Accessory foods. Attempts to grow marine diatom *Thalassiosira gravida*.

4. Plants and Trees.—Pickering (1903, 1911, 1914). Woburn fruit-tree experiments. Inhibition due to toxins. Burmeister—quoted by Russell (1927)—claims that couch (*Triticum*, or *Agropyron repens*) increased yield of oats, and Dr. Brenchley found that certain weeds had the same effect on yield of wheat per plant.

Maintenance of Association of Oil and Starch Groups of Algæ in all Strata of Water.

We have another problem to deal with—i.e., the maintenance of algal association in large areas of water and under all conditions of dispersal and depths.

We have particulars from Captain G. C. C. Damant of the swarming of *Phæocystis globosa* off the north coast of Ireland, Lough Swilly, which was observed for seven years. For five out of the seven years the algal swarm was sufficiently intense in all strata to 120 feet to obscure the light and prevent diving operations for two or three weeks during April and May.

Wimmer (1929) records blue-green algæ and diatoms in all strata to a depth of 60 feet in Wauwatosa Pool, U.S.A.

Birge and Juday (1919) record blue-green algæ and diatoms :—

Finger Lakes of New York :—		
In Seneca Lake ..	.. 500 feet	In quantities and in all strata.
In Cayuga Lake ..	.. 300 "	
In Canandaigua Lake	.. 200 "	
Green Lake, Wisconsin	.. 200 "	

Algæ and Change of Method of Nutrition from Holophytic to Saprophytic.

Dr. Bristol Roach, quoted by Russell (1927), in his account of algal development, states that "algæ grow in two very different conditions of the soil :—

"1. On the surface exposed to light, where, by means of their chlorophyll, they fix the energy of sunlight and assimilate carbon dioxide.

"2. In the depths of the soil beyond the reach of light, where the chlorophyll ceases to function (though it may still remain in being), and the organisms obtain their energy and carbon from preformed organic matter, i.e., they live saprophytically.

"The chlorophyll apparatus may, therefore, be regarded as supplementary, coming into play when light is available, but not otherwise."

We can roughly divide the freshwater algæ into two groups :—(1) Motile, with or without an eyespot ; (2) Non-motile, without eyespot.

Under the heading of the former we take the bulk of the genera composing the starch group Isokontæ and the two oil groups Chrysophyceæ and

Dinophyceæ. The latter has the oil groups Bacillariales and the starch group Myxophyceæ.

Wind, vertical and horizontal currents, would have the effect of distributing the two non-motile groups Bacillariales and Myxophyceæ amongst the various strata of the water; but if reserve of oil was sufficient they would tend to float to the surface, otherwise they remain wherever wind and currents place them, with a tendency to sink, gradually reaching bottom.

We have seen that subterranean algæ and diatoms can exist and even flourish in darkness by becoming saprophytes. Owing to the depths at which algæ and diatoms have been found, in various waters far beyond the limits allowed for photosynthetic activities to be carried on, we can appreciate that, if the soil algæ change their methods of nutrition from holophytic to saprophytic, a similar change may take place with aquatic diatoms and blue-green algæ.

Moved by various conditions of wind and currents out of the illuminated areas, they do not succumb, but adapt themselves to their new environment, becoming saprophytes. The food substances necessary for a saprophytic existence are less complex chemically, consisting of materials dissolved out of the disintegrating bodies of animals and plants. We cannot impose any limits of depth to which a saprophyte can exist.

Reduction of temperature, as we have seen, does not, within the limits stated, restrict algal growth.

With regard to light influence on the motile groups, Isokontæ, Dinophyceæ, and Chrysophyceæ, most of the genera are very sensitive to intense light.

We are not on very firm ground concerning the action of light. Under ideal conditions of water clearness and the sun at its zenith, at the Equator and in conjunction with such lakes as Victoria Nyanza, direct sun rays striking the surface of the water at right angles would penetrate to a greater depth than 30 feet, which is the annual mean light visibility of a white disc lowered into freshwater lakes (F. A. Forel, quoted by Arber (1920)).

Damant, however, states that light penetration occurs in the ocean to a depth of 120 feet of sufficient intensity to permit diving operations to be carried on. With the aid of flagella the motile algæ could retire to a position where light intensity was agreeable, even temporarily to greater depths than 30 feet. As the sunlight became less intense, due to increasing reflection at the surface of the rays of the setting sun, light intensity would rapidly diminish. Phototropism would act and restore these migrating algæ to the upper layers of the water. In the upper strata of the water we have a continual movement of the motile algæ, Chrysophyceæ, Dinophyceæ (oil), and some of the Isokontæ (starch), due to a diurnal rise and fall.* At greater depths,

* The movement of herring shoals is a manifestation of diurnal movement and phototropism of the plankton. When trawling, the best hauls of herring are made midday (J. J. Jenkins, 1920, "The Sea Fisheries," p. 51). When the nets (drifters) have been in the water for a considerable time at night, with the sky clear, few fishes came into them until the moon rose, when they have been almost instantly filled (J. M. Mitchell, 1864, "The Herring," p. 32).

quantities in all strata of non-motile forms, Myxophyceæ and Bacillariales —these two classes, however, when beyond the illuminated area may become saprophytes—under these changed conditions the kind of association that is established, if any, has to be demonstrated.

Oxidation of Accessory Foods in Fast-Moving Waters Checks Swarming of Algæ.

Our final remarks are concerned with the swarming of phytoplankton, most pronounced in still water, much less so in moderate or absent in fast-running water, and the cause of such variation.

Our attention was first drawn to the inequality of microflora in still and running waters when gathering in a backwater of the New River and the river itself. Similar experiences have been recorded by other workers. The plankton of rivers are clearly subject to more catastrophic changes than those of lakes.

The difficulties of obtaining desirable records for comparison of phytoplankton that occur in varying movements of water are obvious. Fortunately, we have in the Jersey records the necessary conditions and data :—

1. Constant movement in the St. Lawrence Stream.
2. Intermittent movement in the settling pond.
3. Comparatively still water in Reservoir D.

A point of great importance, the make-up of the water, is similar at the three sampling stations.

The gatherings recorded were made on the same dates, and our totals include all the diatoms and Chlorophyceæ.

Movements.		Active. Stream. Total Counts.	Intermittent. Settling Pond. Total Counts.	Still. Reservoir D. Total Counts.
Nov. 6, 1922, to Feb. 16, 1923	14 weeks	432	No records	5,511
Feb. 18 to Apl. 3 ..	6 ,,	444	3,584	14,328
Apl. 15 to Aug. 19 ..	18 ,,	2,910	5,840	36,482
Aug. 26 to Oct. 14 ..	7 ,,	708	1,336	5,500

Average one sample 500 c.c. per week at each station.

Four periods at different parts of the year give similar results—a progressive increase in the phytoplankton passing from constantly moving to intermittent, then into still water.

Arising out of these observations on the swarming of phytoplankton we have devised a simple arrangement to prevent rapid development of algal growth in filter-beds of waterworks without disturbing the important part of the filter, i.e., the algal filter film. We hope to have an opportunity of

trying out this scheme in a practical manner. If successful, its application to filter-beds would represent an enormous saving to the water companies in limiting the costs of cleaning and renewing.

Houston (1924) states that "growths which give most trouble in connection with filtration are Asterionella, Fragilaria, Cyclotella, and Stephanodiscus.

"It is no exaggeration to say that diatom development may choke sand filters in a few days, whereas normally their life extends into weeks or months."

Summary.

1. Division of the phytoplankton into two main groups according to food reserves, roughly starch and oil, and an association between them is demonstrated. A succession of genera is shown of the same, and between different, classes in the oil and starch groups, due to action and interaction —inhibition and stimulation of growth—by autotoxins (excretion products).

2. Toxic effects do not occur between an "oil" and a "starch." Swarming (increase and decrease) of genera of the two groups is due to the available quantity of accessory food. The toxin of the oil group becomes an accessory food of the starch group, and conversely.

3. Inhibition by autotoxin is necessary to avoid the tendency towards permanent supremacy of the dominants in each of the classes.

4. While maintenance of chemical (essential foods) and physical conditions is necessary to allow normal algal development, swarming of the phytoplankton is due to the available quantity of accessory foods.

5. The exchange of excretion products is maintained at all temperatures within limits possible for algal growth on stones, land, and in water.

6. At depths beyond the illuminated areas the non-motile algæ, Bacillariales and Myxophyceæ, and some Isokontæ, may continue their activities by changing the method of nutrition from that of holophytes to saprophytes after the manner of the subterranean algæ.

8. Variation of oxidation of accessory food reduces or increases swarming. Oxidation is definite in fast-running, less so in moderately-moving, and absent in calm waters; the swarming of phytoplankton is also governed by the prevalence of these conditions.

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XIII.—ON THE PREPARATION OF EEL SCALES.

By Dr. Alfonso Gandolfi Hornyold, F.Z.S., F.R.M.S.

(*Communicated by* Dr. Tierney, *April* 15, 1931.)

Eel scales make very beautiful objects for the microscope, especially when a low power dark-ground illuminator or polarized light is used.

It was by no means easy to prepare the scales, and working on eels was a very messy task, on account of the slime or mucus, before the improved method here recorded was worked out.

The great difficulty was to remove the mucus, and formerly I used talcum powder, which gave good results. This method was as follows:—

First remove all slime or mucus from the skin by rubbing it several times with talcum, and afterwards with cotton-wool steeped in 90 p.c. alcohol.

The skin is then moistened again with water, and by scraping with a sharp dissecting knife the scales are easily removed and placed in water.

If the skin has been properly cleaned in the way just stated, one can count the zones at once or mount them, otherwise one must macerate the scales for 24 hours or more, and centrifuge them, changing the water several times.

One great inconvenience of this method was that the talcum formed a paste with the slime, which dried on the hands, forming a skin, very difficult to remove even with substances such as monkey soap.

But the greatest drawback of this method was that it took much time, and removing the slime from a large number of eels, as was often necessary when determining the age, was very strenuous work indeed.

It was much more difficult to remove the slime from silver eels than from yellow eels, and especially from large silver females.

After many experiments I worked out a very simple method which gives perfect results, and can also be used for killing the eels without damaging them.

The eels are placed in a bucket which, in the case of live eels, is covered with a fine-meshed net. A spirit or mercurial thermometer with a large scale is attached to the net; it is advisable to cover the net with a large duster. Water at 52° Centigrade is then poured into the basket, thereby killing the eels and coagulating the mucus. Should the water be too cold, more hot water is added till the temperature of 52° C. is reached again. The lethal temperature is 45° C.

After 2 to 3 minutes the eels are transferred to another bucket filled with cold water, and after a few minutes the coagulated mucus can be easily removed by washing under the tap. The skin is rubbed down with a piece of linen or cotton-wool moistened with water, and the scales are then very easily removed by scraping with a dissecting knife. The separated scales are then placed in a test tube, half filled with water, and shaken up two or three times, the liquid being changed each time and replaced by clean water.

If these directions are properly carried out, perfectly clean scales ready for mounting are obtained, generally after shaking up the scales in the test tube once or twice.

Naturally, too hot water damages the skin and also the scales, and I do not advise using water above 55° Centigrade; 52° is sufficient.

For mounting scales I find that glycerine gelatine gives the best results, as both Venetian turpentine and Canada balsam make the scales too transparent.

For the determination of the age of the scales, this method is most useful, and the scales of a hundred eels can quite easily be prepared in a day; all the messiness of eel work also is completely done away with. I generally prepare the scales of fifty small eels at a time.

The oldest scales, with, therefore, the largest number of zones, are to be found in front of the anus, above the lateral line, and for determining the age the scales should be removed from this region.

For scale reading it is not necessary to mount them, as they can be examined in water on a spoiled stereoscopic plate or, what is much more convenient, in a Petri dish.

The most useful powers for scale work are 1½ in., 1 in., and ½ in., and a microscope with a large stage is indispensable. An instrument with a Porro prism is most convenient, as any curious or interesting scale can be isolated and selected with the greatest ease. A condenser is not necessary.

In my paper "The Age and Growth of Some Eels from a Small Worcestershire Pond," published in this Journal in 1922, pp. 10–26, I reproduced drawings of a few forms of irregular scales, which are produced by two or more scales growing together. Those who may prepare the scales of many eels are sure to find many other curious and interesting forms, which make fine objects for the microscope.

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XIV.—NOTES ON ULTRA-VIOLET MICROSCOPY.

By B. K. Johnson, F.R.M.S.

(Asst. Lecturer in the Technical Optics Department of the Imperial College of Science and Technology).

(*Read March* 18, 1931.)

Four Plates.

The work of Mr. J. E. Barnard (in this country) and of Mr. F. F. Lucas (in America), in connection with ultra-violet microscopy, is now well known. The present writer has also had an opportunity, in recent years, of carrying out researches in this subject, and in following up the work it was deemed advisable at times to take photomicrographs of certain types of well-known objects which are frequently photographed with visual light, in order to compare the results obtained by the two methods. Some of these ultra-violet photomicrographs have been exhibited, but it was thought that the publication of the more inportant ones, together with a few notes, might prove of interest.

It will be recalled that the purpose of using light of shorter wave-length than the visible spectrum with the microscope is to increase the resolving power of the latter; for the physical limit $\left(d = \frac{0 \cdot 61\lambda}{\text{N.A.}}\right)$ which governs the resolving power of a microscope objective tells us that the latter is directly proportional to the wave-length employed. Up to the present, radiation of wave-length 0·275 microns has been chiefly used for ultra-violet microscopy, and thus an increase of 100 p.c. in the resolving power over an objective used with light of wave-length $0 \cdot 55\mu$ would be theoretically expected.

A method of obtaining a numerical value for the resolving power of a microscope objective was described by the writer in a paper in the Society's Journal 1928, **48.144**, and this method has now been further applied to the testing of some quartz monochromat objectives, with the idea of determining how much increased resolution really was being obtained by using light of half the wave-length of the visible spectrum (green). This test was fully described in a paper to the Physical Society of London, and revealed the fact that an object interval of 0·000130 mm. was approximately the limit of resolution for the highest-power ultra-violet objective (2 mm. immersion quartz monochromat) when used with $\lambda = 0 \cdot 275\mu$. Fig. 1 shows a line

FIG. 1.

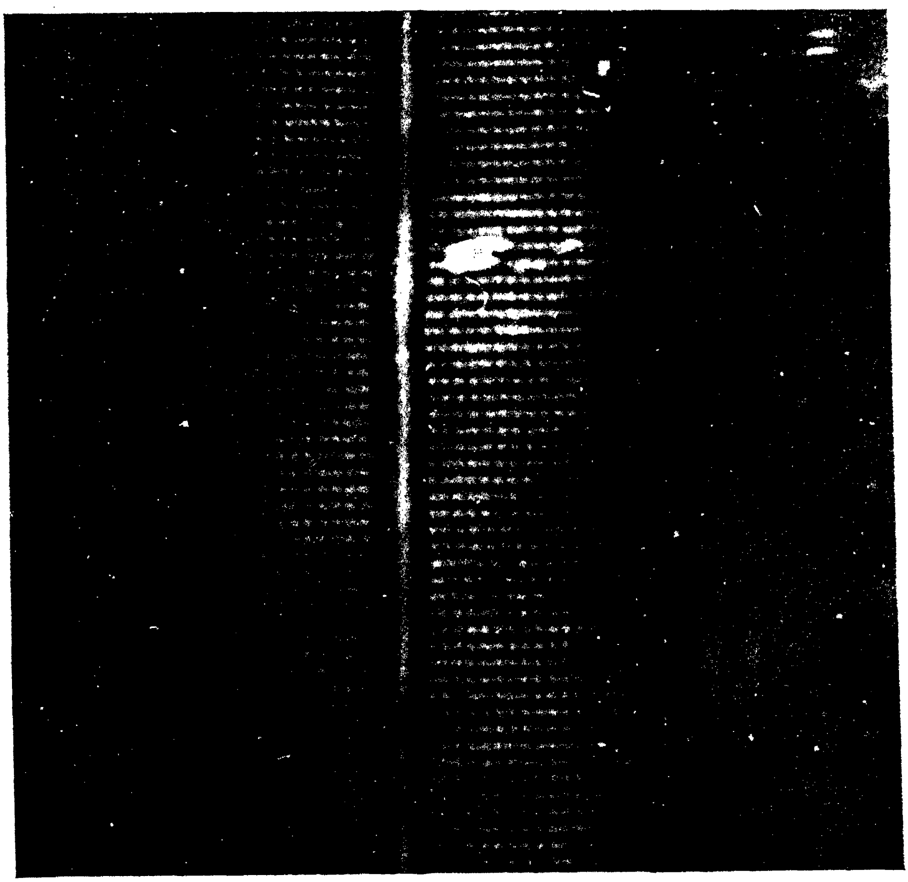

FIG. 2.

Face p. 26

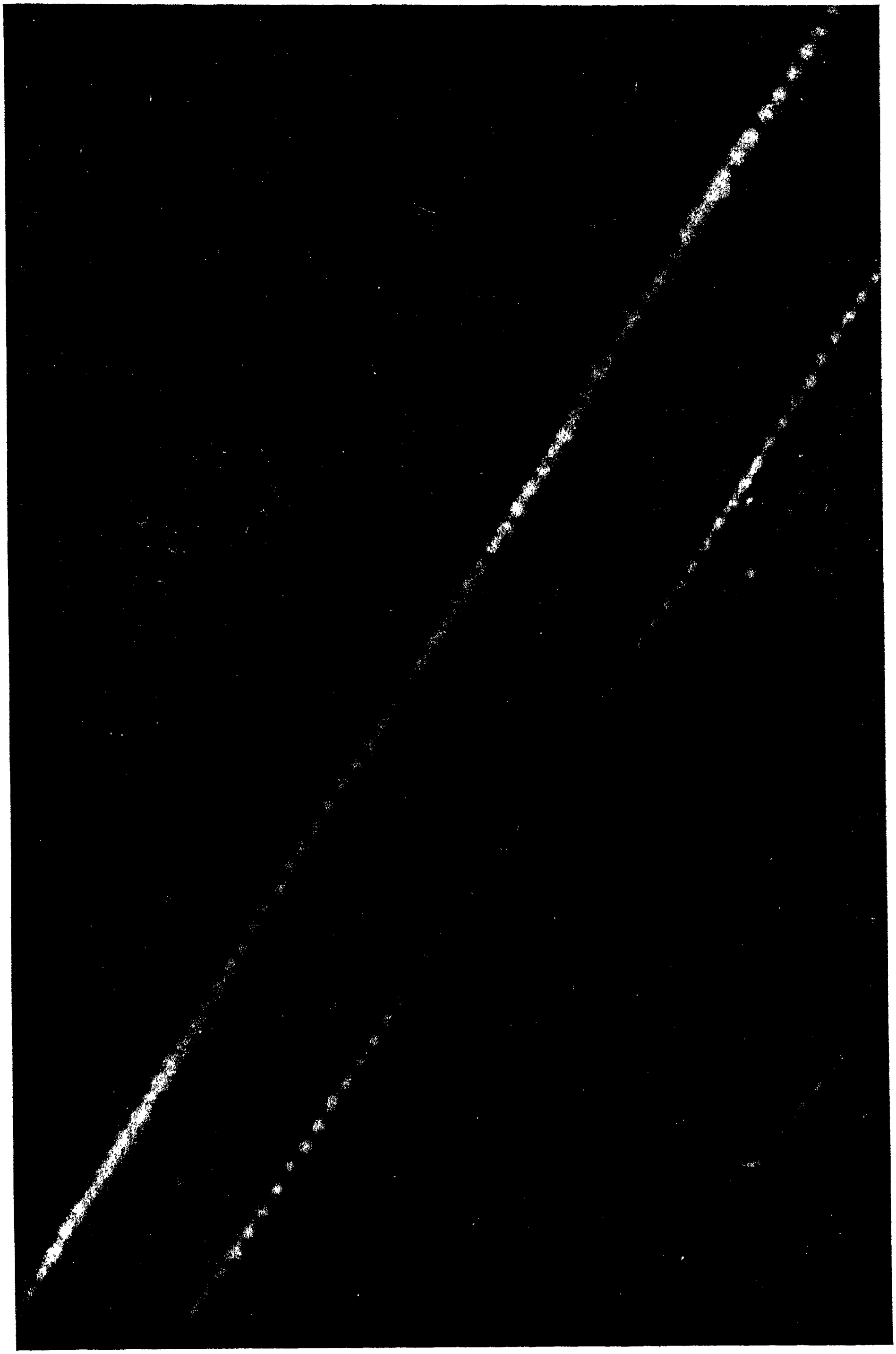

Fig. 3.

Face p. 268.

interval of such dimensions (approx. 200,000 lines per inch) clearly resolved taken under conditions described in the above-mentioned paper.

Qualitative comparisons, using well-known types of specimens, have also been made. Two of these taken with transmitted light ($\lambda = 0 \cdot 275\mu$) —*direct* illumination—are shown in figs. 2 and 3. It may be of interest to note the way in which the striations parallel to the rib have been revealed in this photograph of *Amphipleura pellucida*.

A fact which is of importance, besides that of increased resolution, is the selective absorption of light of this wave-length ($\lambda = 0 \cdot 275\mu$) by some biological specimens; in this connection Köhler and Tobgy (1928) have recently taken some ultra-violet photographs of sections of the cornea and other parts of the eye in which the effect of change in wave-length is strikingly brought out.

Lately, I have had an opportunity of using the ultra-violet microscope for the photography of metal specimens. Certain difficulties present themselves in such work, one of which is due to the decrease in reflecting power of metals with the reduction in wave-length, which fact results in an increase in the necessary exposure. In ultra-violet microscopy long exposure (i.e., of the order of 1 to 2 minutes) may spell failure in the attempt to obtain a sharply focused image on the plate, owing to such things as change in refractive index of the immersion fluid used with a monochromat objective, or vibration of the instrument. So that before the ultra-violet metallographic work was commenced, the writer carried out experiments with a view to increasing the intrinsic brightness of the source of light (*see* reference 3). By suitable electrical conditions for the spark discharge, its intrinsic brightness was very greatly increased, and it is undoubtedly due to this fact and the special immersion fluid that it has been possible to obtain the accompanying ultra-violet photomicrographs of metal specimens.

Fig. 4, *a* and *b*, show comparison photographs of the *same part* of a metal specimen (an $0 \cdot 8$ p.c. carbon steel) taken with a 2 mm. visual and a 2 mm. ultra-violet objective respectively, and illustrate the increased resolution obtained by the use of the shorter wave-length.

Fig. 5, *a* and *b*, are comparisons of the *same part* of a metal specimen photographed with lower-power objectives, to show the effect of selective reflection due to the short wave-length. The lenses (an 8 mm. visual and a 6 mm. ultra-violet) had approximately the same theoretical resolving power when used with their appropriate wave-length, so that the difference in appearance is due solely to the behaviour of the specimen in its reflecting capabilities under the influence of the shorter wave-length rather than to a difference in resolution.

Fig. 6, *c* and *d*, show high-power comparisons taken of the troostitic structure in steel—well known as a structure in which it is difficult to reveal detail. On close inspection of the prints, the increased resolution (due to the use of ultra-violet illumination) will be apparent.

Mention should be made of the type of " vertical illuminator " used in

this work; it consists of a thin film of methylated collodion mounted on a suitable framework. (The method of making and mounting these has been described by the writer elsewhere.) Such a film, besides being transparent to the ultra-violet region, is distinctly superior, from an optical point of view, to many of the existing forms of vertical illuminator plate; moreover, it is so thin (a few wave-lengths of light) that no troublesome effects due to "double reflection" are experienced. The writer would urge the more extensive use of this valuable adjunct for vertical illuminator work.

The apparatus employed in taking these ultra-violet photomicrographs has already been described (*see* Martin and Johnson (1928)). Some of the work has been done with the Barnard-Beck instrument, and some with the apparatus (described by Prof. Martin and myself) in which the extremely small movements involved in focusing are produced by a controlled stressing of the stage on which the object is mounted.

Thus the results obtained by tests on various types of object indicate that there is undoubtedly a distinct advantage to be obtained (in practice as well as in theory) by using ultra-violet radiation with the microscope. If the apparatus can only be used by a greater number of workers than has hitherto been the case, I feel sure that valuable information would result. Any small efforts that I have made in trying to make this instrument of more general use will be well rewarded should it prove, in the future, the means of contributing to our knowledge.

In conclusion, I would like to express my thanks to Sir Robert Hadfield, who kindly provided me with the metal specimens, and who has given me permission to publish figs. 4, 5 and 6; also to Prof. Martin, who worked in conjunction with me when taking photographs 2 and 3.

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FIG. 4 (*a*).

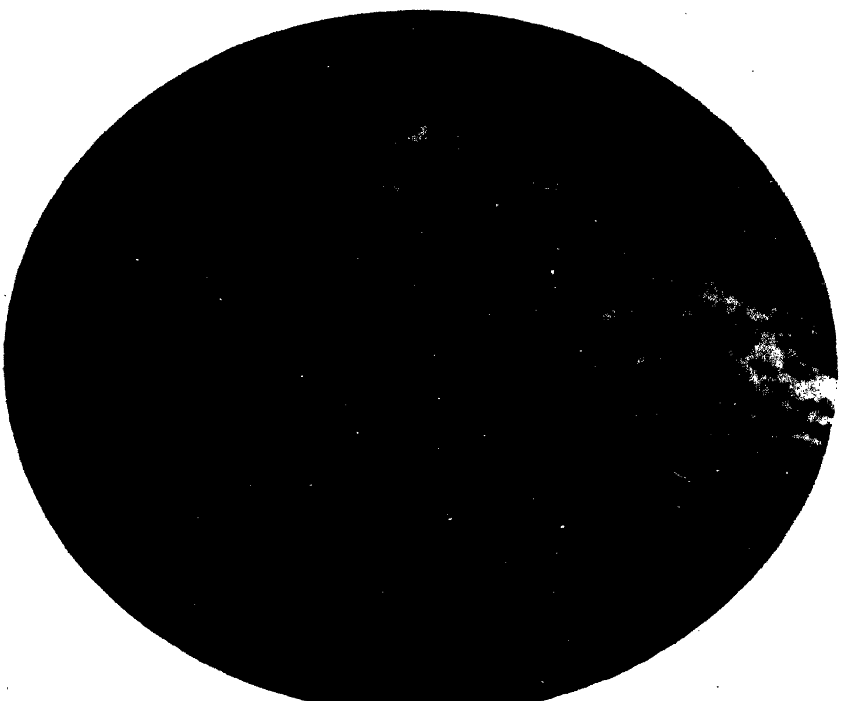

FIG. 4 (*b*).

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FIG. 5 (*b*).

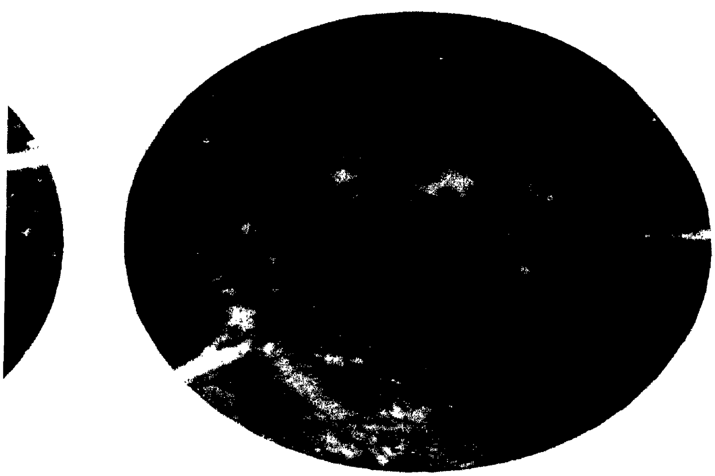

FIG. 6 (*b*).

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1.—200,000 lines per inch, taken by the method described in the paper referred to in the text. Magnification = 6,700 × (enlarged eight times from negative). Objective = 2 mm. immersion (quartz) monochromat. Numerical aperture = 1·2. Wave-length of light employed $\lambda = 0{\cdot}275\mu$.

Fig. 2.—*Amphipleura pellucida* (in air). Magnification = 6,300 × (enlarged 3 times from negative). Objective = 2 mm. monochromat (Beck). N.A. = 1·2. Wave-length of light $\lambda = 0{\cdot}275\mu$.

PLATE II.

Fig. 3.—*Navicula rhomboides.* Magnification = 8,000 × (enlarged 4 times from negative). Objective = 2 mm. monochromat (Beck). N.A. = 1·2. Wave-length of light $\lambda = 0{\cdot}275\mu$.

PLATE III.

Fig. 4.—Comparison photomicrographs of the same part of a metal specimen (an 0·8 p.c. carbon steel), using the highest-power visual and ultra-violet objectives, showing the increase in resolving power by the use of the shorter wave-length.

a.—Magnification = 5,000 × (enlarged 2½ times from negative). Objective = 2 mm. apochromat. N.A. = 1·30. Wave-length $\lambda = 0{\cdot}45\mu$.

b.—Magnification = 5,000 × (enlarged 2½ times from negative). Objective = 1·7 mm. monochromat (Zeiss). N.A. = 1·25. Wave-length $\lambda = 0{\cdot}275\mu$.

PLATE IV.

Fig. 5.—Comparison photomicrographs of the same part of a metal specimen (an 0·8 p.c. carbon steel), using low-power visual and ultra-violet lenses, showing selective reflection with shorter wave-length.

a.—Magnification = 900 × (enlarged 1½ times from negative). Objective = 8 mm. achromat. N.A. = 0·56. Wave-length $\lambda = 0{\cdot}45\mu$.

b.—Magnification = 900 × (enlarged 1½ times from negative). Objective = 6 mm. monochromat (Zeiss). N.A. = 0·35. Wave-length $\lambda = 0{\cdot}275\mu$.

Fig. 6.—Comparison photomicrographs of the same part of an 0·9 p.c. carbon steel—troostitic structure—taken with highest-power visual and ultra-violet objectives.

c.—Magnification = 3,000 × (enlarged 1½ times from negative). Objective = 2 mm. apochromat. Wave-length $\lambda = 0{\cdot}45\mu$.

d.—Magnification = 3,000 × (enlarged 1½ times from negative). Objective = 1·7 mm. monochromat (Zeiss). N.A. = 1·25. Wave-length $\lambda = 0{\cdot}275\mu$.

535. 42. XV.—EXPERIMENTAL STUDIES IN DIFFRACTION. III.

By Fredk. W. Shurlock.

Three Plates.

Abbe's Diffraction Experiments.

Abbe's diffraction experiments were made with (*a*) a grating consisting of alternate long and short lines so arranged that the separation of the lines in one-half of the field is twice the separation of the lines in the other half; (*b*) a crossed grating in which the two sets of lines are at right angles to each other; (*c*) a crossed grating in which the two sets of lines cut each other at an angle of 60°.

These gratings were examined under the microscope, one or more slits or circular apertures being mounted in a plane a little above the back focal plane of the objective, so as to permit of rotation about the axis of the instrument. Spectra are formed behind the objective, and the observed images were explained as the consequence of the particular selection of spectra from which the light was allowed to pass. The experiments are described in Prof. Cheshire's article "Some Abbe Letters," in the Journal of the Royal Microscopical Society for September, 1921.

The experiments described below were made with the Abbe diffraction apparatus supplied by Messrs. Zeiss for the demonstration of Abbe's experiments. This apparatus consists of a diffraction plate and a rotating fitting which carries the stop with the apertures and is inserted between the microscope tube and the *aa* objective of 26 mm. focal length and 0·17 N.A., for which the apertures are designed. A continuous current arc was employed as the source of light.

The diffraction plate is a microscope slide on which are three minute gratings of the form previously described. It will be convenient to call the grating with alternate long and short lines the double grating; to call the grating in which the two sets of lines cross at right angles, and in which the meshes are square, the square grating; and the grating in which the lines cross at an angle of 60°, and in which each mesh is a rhombus, the rhombus grating. The thickness of the line in all the gratings is from 1 to 2μ. The separation of the lines in the two halves of the double grating is about 4μ and 8μ respectively. In the square grating and the rhombus grating the separation of the lines is about 10μ, and these gratings only differ in the

angle at which the two sets of lines cross each other. Each set in the crossed gratings consists of 50 lines.

The spectra formed by the objective were photographed with a Goerz photographic lens of 5·3 inches focal length. Fig. 1 is a photograph of the spectra formed by the coarser half of the double grating. Fig. 2 shows the spectra formed by the finer half of the same grating. Fig. 3 shows the spectra formed by the square grating, and fig. 4 shows the spectra formed by the rhombus grating.

The Double Grating.

Figs. 5, 6, 7 and 8 are photographs of the Abbe experiments with the double grating, taken with the Zeiss *aa* objective. Fig. 5 is a photograph of the grating. To obtain fig. 6, the finer of the two single slits (about 1 mm. in width) was inserted parallel to the lines of the grating, with the result that the lines were obliterated in both halves of the field. Fig. 7 was taken with the wider of the two single slits (about 1·5 mm. wide) parallel to the lines of the grating, the finer lines only being obliterated in this case. Fig. 8 was taken with the triple slit (3 slits 1 mm. wide, with their centres 2 mm. apart), and it will be seen that the finer lines are now continuous throughout, being doubled in one-half of the field. The finer half of the grating appears the brighter in each case, since it passes twice the amount of light. Comment on these results is deferred until the crossed gratings have been considered.

The Square Grating.

Photographs were taken, in the first instance, of the square grating with the *aa* objective which forms part of the Zeiss apparatus, the finer of the two single slits being inserted behind the objective.

In accordance with Abbe's statement, we obtain, on rotating the slit, two sets of similarly spaced lines parallel respectively to the sides of the square, and two sets of finer lines parallel respectively to the diagonals. The separation of the two sets parallel to the sides of the square is to the separation of those parallel to the diagonals in the rato of $\sqrt{2}:1$. The direction of the lines is in each case at right angles to the direction of the slit.

Figs. 9, 10, 11, 12 are photographs of these effects. Lantern slides were made from the negatives and the figures projected on a screen. This enables the details to be conveniently observed and the numerical relations to be verified.

Fig. 9 shows the vertical lines of the grating. Fig. 10 shows the horizontal lines. The white lines, when examined with a lens or by projection, appear to consist of short linear elements inclined at an angle of about $26\frac{1}{2}°$ to the horizontal lines or $18\frac{1}{2}°$ to the diagonal lines. In the absence of any means of accurately adjusting the slit at right angles to the lines of the grating, it is probable that the slit was inclined to these lines. Fig. 11 shows

fine diagonal lines which are practically continuous. The white lines are, however, seen to consist of short elements inclined at an angle of 13° to the diagonal. Fig. 12 shows fine diagonal lines. The white lines are again found to consist of short linear elements inclined at an angle of 18° to the lines.

The Zeiss objective was then replaced by a No. 3 Leitz objective of 16·2 mm. focal length and 0·30 N.A. This has the effect of increasing the magnification as well as of increasing the distance of the slit from the back focal plane of the lens. (It has been pointed out* that in Abbe's experiment the slit is about ¾ inch from the focal plane.) Similar results were obtained, but with interesting modifications.

Fig. 13 shows continuous vertical lines, the slit being at right angles to the lines. One side of the dark lines is more deeply shaded than the other. Fig. 14 shows continuous horizontal lines, the slit being again at right angles to the lines. In this case the centre of the dark lines is less deeply shaded than the sides. Fig. 15 shows discontinuous vertical white lines consisting of short linear elements inclined at an angle of about 28° to the vertical lines, the slit being in a position intermediate between those which give the continuous vertical lines and lines parallel to a diagonal. Fig. 16 shows discontinuous vertical white lines consisting of short elements inclined to the vertical lines at an angle of about 21½° to the vertical lines. The slit is in a position intermediate between those which give the continuous vertical lines and lines parallel to the second diagonal.

Examining these photographs with a lens, or, preferably, by projection on a screen, it is clear that a bright line parallel to the sides of the square corresponds to a row of square meshes, and that each of the short elements corresponds to a square mesh. We conclude, therefore, that each element is the image of a mesh modified by the diffracting action of the slit.

The experiments indicate that the long axis of the elements is at right angles to the length of the slit and rotates with it, and this suffices to explain the formation and spacing of the lines in the image in Abbe's experiments as due to the form of the image of a mesh, when the slit is in position, and the geometry of the grating. The short elements of which the white lines consist have been identified with the images of the meshes of the grating. It is clear from figs. 23–28† in the paper "Experiments Illustrating the Wave Theory" that the image of a small area (e.g., a pinhole, when the light passes through a slit of suitable width) is elongated in a direction at right angles to that of the slit, and that this effect does not greatly depend on the shape of the small area. The position of the image of any mesh will be determined by the rules of geometrical optics, and the centre of each element will be at the intersection of the diagonals of the corresponding mesh in the image of the grating. As the elements of which the white lines consist rotate with the slit, the long axes of the elements will be collinear when they are

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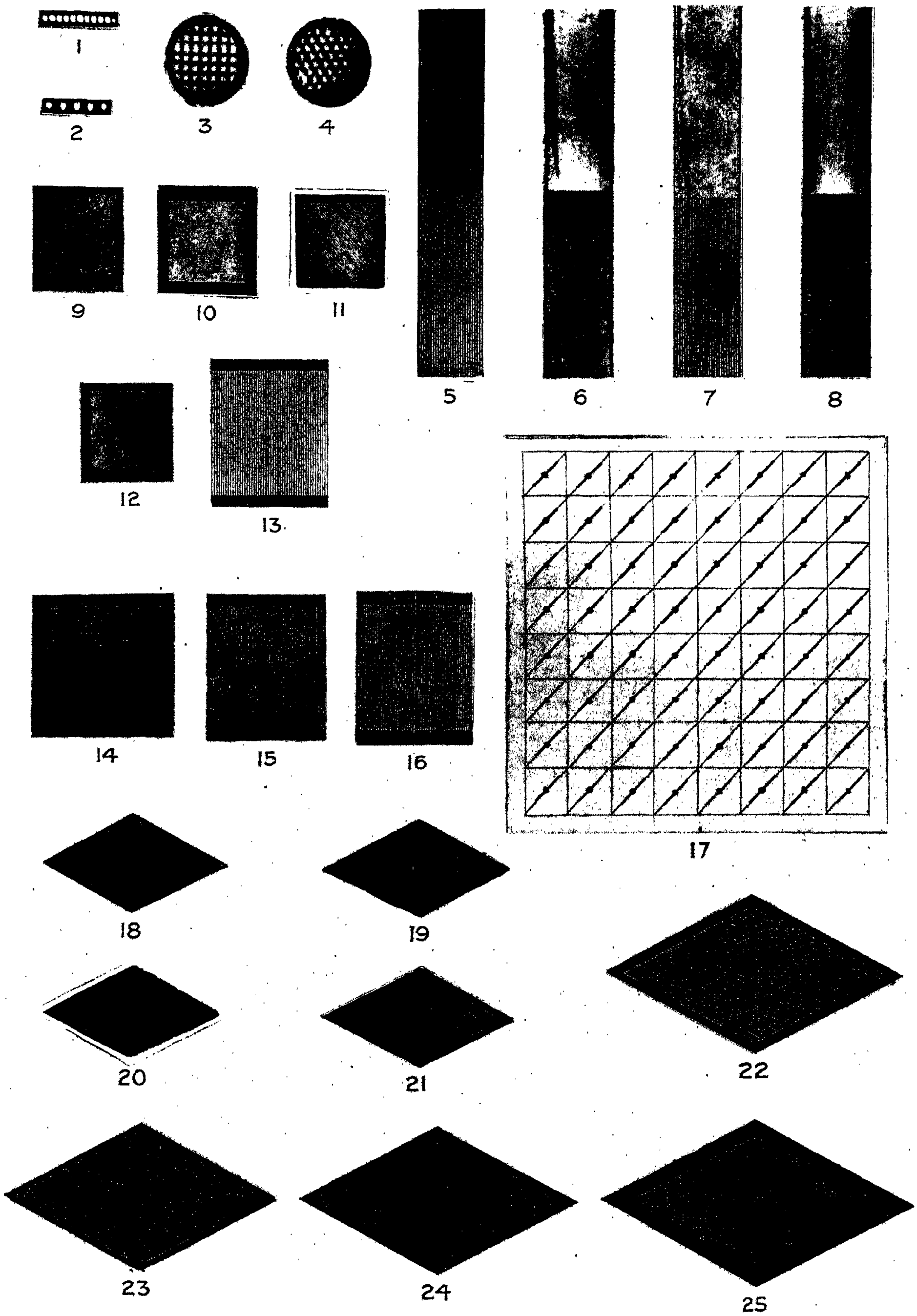
* Conrad Beck: Cantor Lectures on "The Microscope."

† J. Roy. Micr. Soc., **51**, pt. 1, 29–30.



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parallel with the sides or parallel with the diagonals of the grating. Whether the lines are continuous or discontinuous will depend on whether the elements overlap or not. This will depend on the length of the elements and on their separation, i.e., it will depend on the magnification. The geometry of the grating image, which is identical with that of the grating, shows that the separation of the lines parallel to the sides of the grating will be to the separation of the lines parallel to the diagonals in the ratio of $\sqrt{2}$ to 1. In intermediate positions of the slit, for which the long axes of the elements are not collinear, they will present the appearance of discontinuous vertical or diagonal lines with the long axes of the elements inclined to the direction of the lines at angles determined by the direction of the slit.

There are, of course, no diagonal lines in the grating corresponding to those which appear in the images, and the discrepancy between structure and image is at first somewhat startling. It should, however, be borne in mind that in our ordinary experience we commonly draw inferences concerning structure from the appearances presented, and confirm our deductions by other observational and experimental evidence, and cases are not uncommon in which the deductions are not supported by the evidence. In this case the discrepancy between the known structure of the grating and the appearance of the image has been traced to the geometry of the grating, and the discrepancy between structure and appearance in the special circumstances of the experiment should cause no surprise. It is, on the other hand, a matter for surprise that the correspondence between structure and appearance should in ordinary circumstances be as close as it is, and it is this general correspondence which seems to call for explanation rather than the occasional discrepancies. It is, of course, very desirable that microscopists should have reliable criteria that will enable them to draw sound conclusions as to structure from the image formed by high-power objectives, and the most hopeful guide would seem to be furnished by a study of the effects of diffraction on the formation of images.

The appearances presented by the images formed by the Leitz objective are somewhat analogous to those seen in a piece of weaving, which may also suggest a false impression of the actual structure. In a piece of cloth woven from two sets of fairly stout threads of different colours, white and brown, for example, at right angles to each other, the white threads of the warp are seen as discontinuous parallel rows of shuttle-shaped stitches, broader at the middle and narrowing towards the ends, which resemble in shape the images of the meshes of the grating. The white stitches in a single row are formed from a single thread of the warp, and are collinear with the thread of which they form part.

The stitches in adjacent threads of the warp are so arranged that the white stitches in one row are opposite to brown gaps in the other, just as the images of the meshes, which form a diagonal row in the images of the square grating, are opposite to gaps in the adjacent lines when the lines are discontinuous. The white stitches may equally be regarded as arranged in

lines parallel to the direction of the weft, with the stitches at right angles to the lines. In this case also the stitches in one row are opposite gaps in the adjacent row, but, viewed in this way, there is no correspondence between appearance and structure. Or, again, the cloth may give the impression of alternate diagonal rows of white and brown stitches, the stitches making an angle of 45° with the rows. In this case also there is no correspondence between appearance and structure.

Fig. 17 shows the arrangement of the images of the meshes in diagonal rows when the length of the slit is parallel to a diagonal.

The Rhombus Grating.

Similar experiments were made with the rhombus grating. With this grating we obtain, for suitable positions of the slit, two sets of lines parallel to the sides, a set parallel to the shorter diagonal, a set parallel to the longer diagonal, and two sets at right angles to the sides. The latter sets are not mentioned in the Abbe letters. The sets of lines parallel to the sides and the set parallel to the shorter diagonal have the same separation.

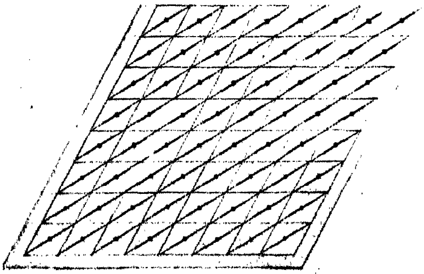
Similarly, the sets of lines parallel to the larger diagonal and the two sets of lines perpendicular to the sides also have the same separation. The separation of these sets is to the separation of the lines parallel to the sides in the ratio of 1 to $\sqrt{3}$.

Figs. 18, 19, 20 and 21 were taken with the Zeiss objective. Fig. 18 shows a set of lines parallel to a side. Fig. 19 shows a set parallel to the shorter diagonal. Fig. 20 shows a set at right angles to a pair of sides. Fig. 21 shows a set parallel to the longer diagonal.

The experiments were repeated with the Leitz objective No. 3, with interesting results. Fig. 22 shows lines parallel to a side. The lines are continuous, but show variations in thickness, suggesting an overlapping of the separate elementary images. Fig. 23 shows lines parallel to the shorter diagonal. In this case the elements are just detached. Fig. 24 shows lines at right angles to a pair of sides. The lines are discontinuous, as the separation of the middle points of the elements of a line is now twice the separation in the lines parallel to the sides of the grating. It will be noticed that the elements may be regarded as arranged in rows parallel to either of two adjacent sides of the rhombus, the inclination of the elements to these lines being 30°, and that the boundaries of the meshes can be traced. Fig. 25 shows lines parallel to the longer diagonal. The lines are discontinuous, and the elements may equally be regarded as arranged in rows parallel to either of two adjacent sides of the rhombus, the inclination of the elements to these lines being 30°. The dark boundaries of the meshes can be traced.

Figs. 26 and 27 show the arrangement of the images of the meshes in the lines parallel to the longer diagonal and the lines perpendicular to the sides respectively.

The experiments support the conclusion that in the image of the rhombus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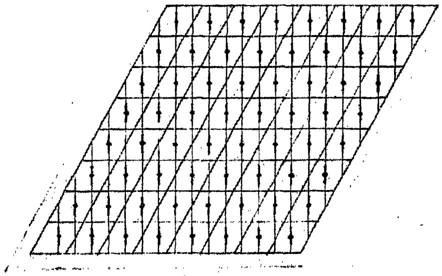
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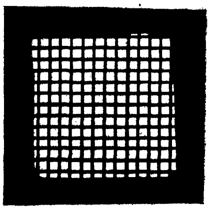
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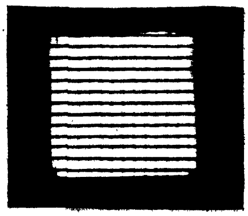
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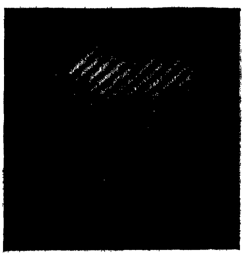
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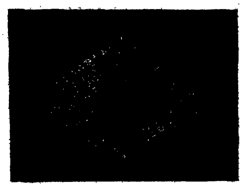
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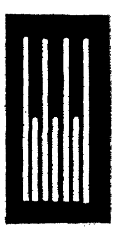
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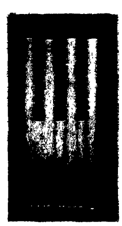
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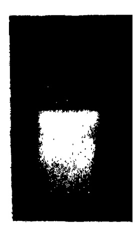
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grating also the white lines are due to the elongated form of the image of the mesh, its orientation with respect to the slit and the geometry of the grating. In both the square and the rhombus gratings the meshes of the grating may be regarded as pinhole apertures, the light from which, after passing through the objective, is diffracted by the slit.

In further confirmation of this view, the experiments may be repeated on a scale suitable for lecture demonstrations. For this purpose the square and rhombus gratings of the Abbe slide may be replaced by suitable pieces of wire gauze and the microscope objective by a photographic lens.

Figs. 28 to 37 were taken in this way with an Aldis anastigmat of 6 in. focal length. The lens was placed about 30 cms. from the wire gauze (of 20 meshes to the inch), and the image was formed on a screen at a similar distance on the other side of the lens, an adjustable slit being placed close to the lens between the lens and screen. The scale of the experiment may be increased if desired. The meshes of the grating used to obtain figs. 28 to 31 were squares, and the slit was in the first place adjusted parallel to one set of wires. Fig. 28 is the image of the gauze taken with the slit in position, but opened to such a width that the image is only slightly impaired by the action of the slit. On closing the slit, figs. 29 and 30 are obtained in succession. Fig. 29 shows the spreading of the light at the side; the vertical lines are fainter, whilst the horizontal lines remain clear. In fig. 30 the vertical lines have disappeared, leaving only the horizontal lines. Readjusting the slit parallel to a diagonal of the square meshes, we obtain, on closing the slit, after some interesting changes, fig. 31, in which the lines are parallel to the other set of diagonals.

To obtain figs. 32 to 37, the gauze was replaced by a piece in which the two sets of wires cross at an angle of 60°, so that each mesh is a rhombus. Fig. 32 is the image of the gauze only slightly impaired by the action of the slit. For fig. 33 the slit was at right angles to a side of the rhombus, so that one set of lines is obliterated. For fig. 34 the slit was parallel to the longer diagonal of the rhombus, whilst the lines obtained are parallel to the shorter diagonal. In the case of fig. 35, the slit was parallel to the shorter diagonal of the rhombus, whilst the lines are parallel to the longer diagonal. For fig. 36 the slit was parallel to a pair of sides, whilst the resulting lines are at right angles to the sides.

Fig. 37 is an interesting figure analogous to fig. 35; in this case the slit is not quite sufficiently closed to give continuous lines, and the separate mesh images may be distinguished.

Returning to the consideration of the double grating, we may regard each bright line in the grating as a series of contiguous elementary mesh sources whose images will necessarily overlap, giving continuous lines in the image of the grating.

When the slit is placed in position at right angles to the lines of the grating, these images are lengthened in the direction of the lines, but do not encroach on the dark spaces, and so do not affect the resolution. When the

slit is rotated, the long axes of the images of the meshes are inclined to the lines and encroach on the dark spaces, the encroachment being greatest when the slit is parallel to the lines of the grating, so that the long axes of the image meshes are at right angles to the lines. The obliteration of the lines in figs. 6 and 7 is thus satisfactorily explained as due to the elongation of the mesh images, the orientation of these images, and the geometry of the grating.

Experiment justifies these conclusions. Attaching the Zeiss *aa* objective to the microscope by means of the Abbe adaptor and focusing the lines of the double grating, we observe, on inserting the 1 mm. slit at right angles to the lines of the grating, that the lines are still perfectly resolved in both halves of the field. On rotating the slit, the finer dark lines become narrower in one-half of the field, and are ultimately obliterated. At this stage the more widely separated bright lines in the other half of the field are obviously broader than at first, and encroach on the dark spaces between them. On continuing the rotation of the slit, the bright lines encroach still further on the dark spaces until finally the latter are obliterated.

Let us now replace the 1 mm. slit by an adjustable slit made to fit the Abbe apparatus. Arranging the slit with its length parallel to the lines of the grating, and adjusting its width in the first instance to about 3 mm., we note that the lines in both halves of the field are perfectly resolved. On gradually closing the slit, the finer dark lines in one-half of the field become indistinct and ultimately vanish. At this stage the bright lines in the other half of the field are obviously widened, encroaching on the dark spaces, and on further reducing the width of the slit, the dark lines are obliterated. In this experiment the long axes of the mesh images remain at right angles to the line of the grating, but increase in length as the slit is closed.

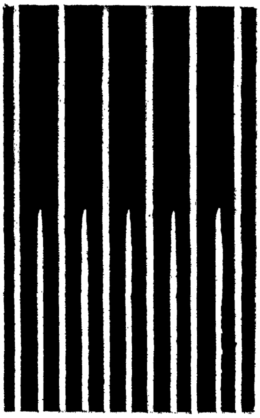
These experiments with the double grating may be repeated on a larger scale, employing a lens of longer focus in place of the microscope objective.

Figs. 38, 39 and 40 are photographs of a double grating taken with the Goerz photographic lens of 5·3 inches focus.

The lens was placed at a distance of about 16 cms. from the grating and the image focused at a distance of about 45 cms. from the lens. An adjustable slit was placed between the lens and the photographic plate at a distance of 38 cms. from the latter.

Fig. 38 is an image of the grating. The width of the slit was from 2 to 3 cms., and it will be observed that the image is not appreciably impaired by the action of the slit. On closing the slit, the bright lines may be observed to broaden, and figs. 39 and 40 are obtained in succession. Fig. 39 represents the stage when the dark lines are obliterated in one-half of the field, whilst the bright lines in the other half are obviously widened. Fig. 40 represents the stage when the dark lines are obliterated in both halves of the field.

It remains to account for the doubling of the lines in one-half of the field shown in fig. 8, and it will be advisable to consider, in the first instance,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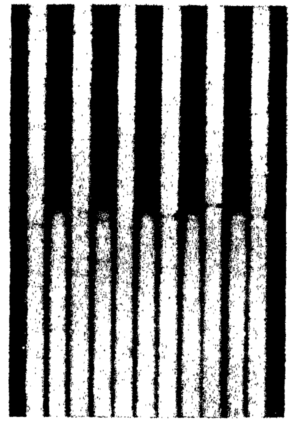
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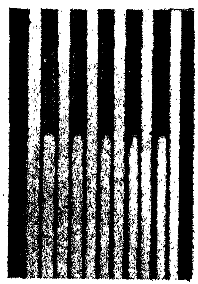
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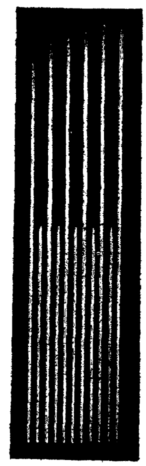
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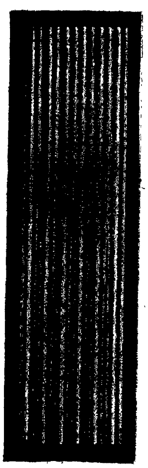
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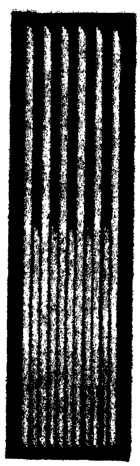
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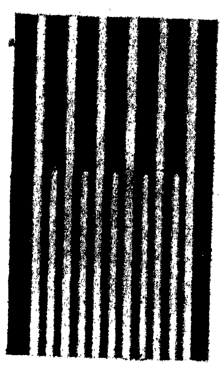
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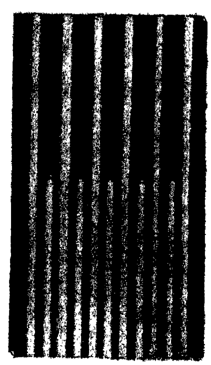
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the effect of introducing the slit between the lens and the image plane on the focused image of the grating.

It is well known that in these circumstances the image of a fine slit is accompanied by one or more diffraction bands on each side. These bands are much fainter than the image, and rapidly decrease in intensity, so that for our present purpose it is only necessary to take into account the first band on each side of the image. It is further to be noted that, in order to obtain these diffraction bands, the slit source must be of less than a certain minimum width, and that the diffracting slit must be closed down until the image just begins to suffer from the broadening effect.

To obtain figs. 41 to 44, a suitable grating was selected and focused by means of the Goerz lens on a screen at a distance of about 107 cms. from the lens. Fig. 41 shows the image of the grating. Fig. 42 shows the effect of inserting a slit at a distance of 100 cms. from the screen. The widening of the image lines and faint traces of diffraction bands may be observed.

On gradually closing the slit, the image lines broaden and the diffraction bands separate from them. Fig. 43 shows an external band on each side of the grating image and a band on each side of the line images, giving two bands between successive image lines in one-half of the field. In fig. 44 these two bands have coalesced into one and thus duplicated in one-half of the field, although the diffraction lines are in this case much fainter than the image lines. On further closing the slit, we merely repeat the phenomena of figs. 39 and 40 on a larger scale, whilst the diffraction lines are obliterated by the broadening of the image lines.

Similar results may be obtained by keeping the width of the slit, as well as the distance from the image plane, constant. This involves focusing the image at different distances from the lens, and hence an alteration of the magnification of the image. Figs. 45 and 46 were obtained in this way, the distance from the slit to the image plane being 47 cms. in each case.

In fig. 45 each image line in one-half of the field is accompanied by its two first order diffraction images, giving two fainter lines between consecutive image lines. The image was focused at a distance of about 92 cms. from the lens. In fig. 46 the first order lines from consecutive line images are superimposed as the result of reducing the scale of the image, and give rise to a single diffraction line between them, the distance from the lens to the image plane being in this case about 51 cms.

It thus appears that the adjustments necessary for obtaining a diffraction line half-way between consecutive image lines may be made within certain limits, either by altering the scale of the image, by adjusting the distance of the slit from the image plane, or by adjusting the width of the slit.

It will have been noticed that in these experiments the diffraction lines are much fainter than the image lines. It has, however, been pointed out by Mr. J. W. Gordon (Proc. Roy. Micr. Soc., Aug., 1901) that the triple slit employed in the Abbe experiment acts as a diffraction grating.

On reference to fig. 17 in the paper "Experiments Illustrating the Wave

Theory," * it will be observed that, when a grating of moderate power is employed to form diffraction images of a slit, the first diffraction images in each side of the direct image are considerably brighter than the remainder.

If, then, the separation of the images of the grating lines is twice the separation of the diffraction images, the diffraction images on opposite sides of adjacent line images will be superimposed, and will give rise to a bright line comparable in intensity to a line image.

This is illustrated in figs. 47 to 49. Fig. 47 is the image of a grating formed by the Goerz lens at about 51 cms. from the lens. To obtain fig. 48, a grating with 150 lines per inch was inserted at a distance of 19 cms. from the image plane. It will be seen that each image line is accompanied by two first order diffraction images in the upper part of the field.

The grating was then removed to a distance of 44 cms. from the image plane. Fig. 49 shows that in this position the lines are doubled in one-half of the field, and that the diffraction lines are comparable in intensity with the line images.

Placing the grating at a distance of 21 cms. from the image plane, we obtain a figure which is practically identical with fig. 48. On rotating the grating in this position, fig. 50 is obtained. Every image line is accompanied by its two first order images, and in the case of the long line faint images of higher orders may be detected.

In each case the two first order images coalesce with the direct image, forming a single broader line. The three images can, however, be clearly distinguished at the end of the lines. The light which, in the absence of the grating, would form the image of a small element of the line, gives rise, when the grating is introduced, to diffraction images which lie along a line through the element and at right angles to the direction of the grating lines. (*Cf.* " Experiments Illustrating Wave Theory " diffraction photographs.)† This effect is evident at the ends of the line in fig. 50. It may be observed in the microscope with the Abbe apparatus. For the purpose it is most convenient to examine the outer ends of the long lines of the double grating. The triple slit is first placed with the length of the slits parallel to the lines of the grating when the first order diffraction images may be seen. On rotating the slit, the ends of the diffraction lines are displaced as in fig. 50. The effect is clearly seen with the Leitz No. 3 objective. It can also be observed, but less clearly, with the Zeiss *aa* objective.

That the triple slit of the Abbe apparatus acts as a diffraction grating is further shown in figs. 51 and 52. To obtain these, the double grating previously employed was focused by the Goerz lens at a distance of about 77 cms. from the lens. The triple slit from the Abbe apparatus was then inserted at a distance of 70 cms. from the image plane. Fig. 51 shows the diffraction lines when the slits were parallel to the grating lines. Fig. 52

* J. Roy. Micr. Soc., **51**, pt. 1, 28.
† *Ibid.*, 26–31.

shows the result when the slits are inclined to the image lines. An effect similar to that of Fig. 50 may be noticed at the upper end of the shorter lines.

The experiments with gratings of moderate power in the paper on "The Formation of Images"* were explained in terms of the distribution of spectra formed in the focal plane of the lens, whilst in discussing the Abbe experiments the explanation is based on the form and distribution of the elementary images in the image plane of small areas in the source which approximate to radiant points. There is in this no contradiction, since the principle involved in each case is a legitimate deduction from the wave theory. The former method can, however, only be conveniently applied when the object consists of parallel and equidistant straight lines, whilst the latter promises to be of greater service in more difficult cases, such as those presented by highly magnified microscope images.

J. Roy. Micr. Soc., **51**, pt. 2, 127-35.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(*Under the direction of* G. M. Findlay, M.D.)

HISTOLOGICAL TECHNIQUE AND STAINING.

A New Embedding Material.—Y. Yoshida ("Kollodionharz Patent, Ein neues Einbettungsmittel," *Folia Anat. Jap.*, 1930, 9, 13–6). A new embedding medium is proposed instead of celloidin. The product, which is registered as No. 42,799 in the Japanese Patent Office, is composed of collodium (Japanese Pharmacopœia) and commercial pine resin. The collodium is filtered and concentrated by evaporation to about half its volume. The resin is broken up and heated at low temperature upon paper to absorb the easily melted impurities. It is dried, pulverized, and hot water is added to it, with constant stirring. The balsam forms a lump while the water gets yellow. This lump is removed and pulverized and two volumes of absolute alcohol are added. Dissolving takes about 24 hours. Then filter the solution, after further alcohol has been added. Evaporate this filtrate on a sand bath. Repeat this procedure about four times. Eventually there is obtained an amorphous yellowish-brown substance devoid of the usual odours of resin, and which, when melted, seems more viscid than the original product. Add 15 p.c. balsam to the collodium and use as in the celloidin method. Sections of desired thickness are cut and, unlike celloidin sections, these may be kept indefinitely in 0·5 p.c. phenol. Before staining, pass the sections through alcohol and ether-alcohol. Use alcohol vapour to soften old pieces, as ether-alcohol is too strong for this material. G. M. F.

A Gram-Pappenheim Stain for Formalin-fixed Tissues.—S. A. Scudder and J. R. Lisa ("A Preliminary Report on a Combined Gram-Pappenheim Stain for Formalin Fixed Tissues," *Stain Technol.*, 1931, 6, 51–2). This stain is said to combine the differential features of the Gram and the Unna-Pappenheim stain for plasma cells. Paraffin sections of tissue fixed in 10 p.c. formalin are used. Flush with crystal violet phosphate solution for from three to five minutes (crystal violet 1 gm., phosphate buffer *p*H 6·6 to 7·0, 10 c.cm., distilled water 90 c.cm.). Decant and flush with iodine solution (sublimed iodine 2 gm., N/1 NaOH 10 c.cm., distilled water 90 c.cm.); decolorize with Merck's pure technical acetone for 10 seconds or less. Decant quickly and avoid the slightest drying of the section. Flush the section with counter-stain for one to two minutes (two parts 2 p.c. aqueous over-ethylated methyl green, similar to Grübler's iodine green, one part ½ p.c. aqueous pyronin yellowish, similar to Grübler's pyronin G; stand for several

hours and mix well before using). Wash in tap water. Blot, but do not dry. Immerse quickly in oil of onganum Cretic. Differentiate less than one minute. Blot. Clear in two changes of bergamot oil. Blot, mount in balsam. The results are as follows: Gram positive bacteria are purple-black. Polynuclear cells have dark blue-purple nuclei and very faint lavender cytoplasm. Small lymphocytes have homogeneous, very deep, clear blue nuclei; the cytoplasm is unstained, or a very faint magenta-violet to magenta. The nuclei of plasma cells are dark navy-blue with cart-wheel arrangement; the cytoplasm is very homogeneous and dark magenta. Endothelial cells have pale blue nuclei with cytoplasm of a light pinkish lavender. Red cells are bronze to red. G. M. F.

The Rapid Coloration of the Cilia of Ciliates.—H. Anselmier ("Recherche sur la coloration rapide des cils des Ciliés," *Pharmaceutica Acta Helvetiæ*, 1930, **5**, 33–41). A review of various methods of staining protozoan cilia is given. Though various fixatives may be used, the best is 2 to 4 p.c. formalin, by applying a drop or two on the living organism. Debris must be eliminated and chemical cleanliness of the slides is as important as when staining for bacterial flagella. Casares-Gil's fluid is used for mordanting (70 p.c. alcohol 30 c.cm., tannin 10 gm., hydrated aluminium chloride 18 gm., 10 gm. zinc chloride in 10 c.cm. of water, added drop by drop, and rosanilin hydrochloride 1·5 gm.); dilute 1 : 4 and filter before using. The mordanting has gone far enough when a variegated tinge appears on the edges; one minute usually. After washing, any of the following stains may be applied: various dilutions of Giemsa's azure-eosin, acid fuchsin, made up by the Ziehl formula; saturated aqueous tropeolin; 10 p.c. aqueous nigrosin with or without 5 p.c. phenol; methylene blue with thymol, phenol or formalin; Ziehl's basic fuchsin; Ehrlich's gentian violet; 0·4 p.c. alcoholic or 2 p.c. aqueous safranin, 5 p.c. aqueous mercurochrome. G. M. F.

The Microscopic Examination of Acid-fast Bacilli.—R. L. Barnhart and F. Eberson ("A Note on the Microscopic Diagnosis of Acid-fast Organisms," *J. Lab. & Clin. Med.*, 1931, **16**, 421). It has been found that a yellowish counterstain brings out the tubercle organism in bolder relief. Equally satisfactory results are obtained by simply utilizing a yellowish light and dispensing with daylight or the daylight electric bulbs. Plain or frosted 50 to 75-watt bulbs are recommended, and the usual Ziehl-Neelsen technique is used, without any counterstain. Acid-fast organisms appear a brilliant red and their identification is simple if the light has a yellowish tinge. G. M. F.

Golgi Staining.—H. M. Smith (*Turtox News*, pub. by General Biol. Supl. House, 1930, **8**, 91–2). The following modification of the Golgi method is described: Fix brain in 10 p.c. formalin for an indefinite period of time and cut slices exactly perpendicular to the surface of the desired portion. Transfer the tissue to 4 p.c. potassium bichromate for from three to five days. Wash in distilled water, blot and place in 0·75 p.c. silver nitrate. Agitate frequently for the first 15 minutes. Change the silver nitrate solution and allow to stand for 24 hours or more. Rub off the precipitate from the surface; while absolute darkness is not essential, a bright light should be avoided. After the silver impregnation rinse the tissue in distilled water and place in 83 p.c. alcohol. Change the alcohol several times within three to four hours, to eliminate all traces of free silver nitrate. Transfer for one hour each through 95 p.c. alcohol, absolute alcohol and ether alcohol. Then place in a thick celloidin solution and incubate for from one to two hours. Block and immerse in chloroform for several hours; transfer to 95 p.c. alcohol

over night. Cut sections 60 to 80μ thick and transfer to absolute alcohol with 10 p.c. chloroform. Transfer to xylol and mount in benzol-damar without a cover glass. The cerebrum is well impregnated if pyramidal cells are seen with their axons and dendrites, the cerebellum if Purkinje cells show up in their entirety. The method has been used successfully on human autopsy material (adult as well as young) and on monkey brain. G. M. F.

The Fixation of Nervous Tissue.—H. A. DAVENPORT ("Block Staining of Nervous Tissue with Silver. II. Trichloracetic Acid, Sulfosalicylic Acid, Hofker's and Carnoy's Fluids as Fixatives," *Stain Technol.*, 1931, **6**, 37–40, 1 text-fig.). With alkaline alcoholic solutions there occurs a shrinkage of nervous tissue and an attempt was made to determine whether the use of acids, which are themselves good protein precipitants, would prevent this shrinking and would also allow of satisfactory silver staining. Alcoholic solutions of sulphosalicylic acid, trichloracetic acid and Hofker's solutions (one part trichloracetic acid, one part acetic acid and eight parts absolute alcohol), all fixed mammalian spinal cord with less shrinkage than ammoniated alcohol, but during the necessary alkalinization, washing and silvering the acid-fixed specimens shrank more than those fixed in alkaline alcohol. Specimens fixed in Carnoy's fluid shrank most of all. Satisfactory silver staining was obtained after all the fixatives. G. M. F.

The Staining of Bacterial Flagella.—C. E. SAFFORD and M. S. FLEISHER ("Method for Staining Bacterial Flagella," *Stain Technol.*, 1931, **6**, 43–5). Chemically-clean slides must be used. An emulsion which is just perceptibly turbid is used; the organisms should be taken from the water of condensation of a 10 to 16 hours agar slope culture. The bacterial emulsion is heated for 30 minutes at 37° C. A few drops of the bacterial emulsion is placed with a pipette on the clean slide and spread by tipping or rocking the slide, excess fluid being drained off. The slide is covered with the fresh fixative, heated to steaming, and then allowed to act for two minutes. The fixative is prepared as follows :—100 c.cm. one-fourth saturated aqueous solution of picric acid, 5 gm. tannic acid, 7·5 gm. ferrous sulphate. The fixative will only keep for 48 hours. Wash with tap-water and dry. Cover the slide with Fontana's spirochæte stain, heat to steaming, then allow to act for one or two minutes. Wash in tap-water and dry. The stain must be freshly prepared as follows :—To 25 c.cm. of 2 p.c. $AgNO_3$, add dilute ammonia till the precipitate, which forms, redissolves; then add more $AgNO_3$ till a faint turbidity results. G. M. F.

The Feulgen Reaction and Protozoa.—L. A. MARGOLENA ("Feulgen's Reaction Applied to Protozoa and Small Worms, mounted *in toto* in Venetian Turpentine," *Stain Technol.*, 1931, **6**, 47–9). Permanent specimens of certain protozoa and small worms are obtained as follows :—The organisms in suspension are killed by Feulgen's fixative (6 p.c. $HgCl_2$ in 2 p.c. aqueous acetic acid) for from 3 to 24 hours. The material is successively transferred to 70 p.c. iodized alcohol, then after 30 minutes to 50 p.c. alcohol, 35 p.c. alcohol, two baths of distilled water; normal HCl. Transfer to cold water and heat to 60° C. for four to five minutes or longer. Cool under running water and wash in distilled water. Stain one to three hours in Feulgen's fuchsin sulphurous acid. Pass through three baths of 200 c.cm. distilled water with 10 c.cm. normal HCl and 1 gm. sodium bisulphite. Transfer to water and then through ascending alcohols to 95 p.c. Counterstain with fast green FCF, orange G or eosin Y in 95 p.c. alcohol. Pass through two changes of absolute alcohol. Place in 10 p.c. Venetian

turpentine and place in a desiccator; mount after the turpentine has become concentrated. If sections are desired, it is best to use paraffin with a melting point of 56° C. with 3 p.c. beeswax. G. M. F.

Celloidin Embedding of Bouin-fixed Histological Material.—L. Bolcek ("Über die Zelloidineinbettung des Bouin-fixierten histologische Materials," *Ztschr. f. Wiss. Mikr.*, 1930, **47**, 334–5). Material fixed in Bouin's fluid cuts poorly after celloidin embedding, possibly owing to the formation of potassium picrate. A method in which alcoholic nitric acid is used for dissolving potassium picrate is proposed. Wash Bouin-fixed material in 70 p.c. alcohol, transfer to 80 p.c. for 10 to 24 hours, 96 p.c. for 24 to 48 hours, changing it two or three times. Next transfer to the following solution: Cedar oil 1 c.cm., absolute alcohol 8 c.cm., origanum oil 2 c.cm., nitric acid, conc. 1 c.cm. Treat in this for 10 to 24 hours for objects of about 10·5 cm. in diameter, and 24 to 48 hours for larger ones. The material softens in this solution and is passed through a few changes of 96 p.c. alcohol in 24 to 48 hours. Then proceed as usual for celloidin embedding.
G. M. F.

Vital Staining.—K. Sato ("Further Study on the Real Nature of Vital Staining," *Folia Anat. Jap.*, 1930, **8**, 391–400). If trypan blue is injected into the rabbit following KCl, more stain is seen in the renal tubules than in a normal animal. If KCl follows trypan blue, very little is left. The reverse happens when $CaCl_2$ is used in the procedure. Trypan blue is made up of two constituents—a red, highly diffusible substance and a blue substance less diffusible. The colour of excreted urine is blue when the stain is injected with KCl, which loosens and swells the cells, and red when injected with $CaCl_2$ (because of the condensation of the cells). Granules observed in the renal tubules are violet-blue to blue in the first case and red-violet to violet in the second, that is, they correspond to the colour of excreted urine. As the renal cells are loosened by potassium they pass the stain easily, so that more comes out in the urine and much of the stain is deposited in the epithelium; the reverse holds for the calcium. Storing of the stain within the living cell thus depends upon intracellular concentration of the stain molecules and also on the permeability of the cell. G. M. F.

Iron Hæmatoxylin and the Staining of Malaria Parasites.—J. A. Sinton and H. W. Mulligan ("The Staining of Malarial Parasites in Blood Smears by the Iron Hæmatoxylin Method," *Ind. J. Med. Res.*, 1930, **17**, 1,329). By removing hæmoglobin from the red cells it is possible to stain the malarial parasites with iron hæmatoxylin. The blood smears are fixed with osmic vapour and are then immersed in Carnoy's fluid for from 5 to 10 minutes, washed in one change of absolute alcohol and left for a few minutes in absolute alcohol. Fixation for from 15 to 30 minutes in Gilson's fluid, followed by 50 p.c. alcohol, gives as good, if not better, results. To remove malarial pigment, transfer through 95 p.c. alcohol to alkaline alcohol (95 p.c. alcohol—96 parts, 1 p.c. caustic potash—4 parts) for several hours. Pass through graded alcohols to water. Mordant in a 1 p.c. aqueous solution of Bordeaux red for 12 to 24 hours; this may be omitted. Mordant in 4 p.c. iron alum for 3 to 18 hours, preferably the latter, and rinse. Stain in Shortt's hæmatoxylin (hæmatoxylin, preferably Grübler's, dissolved by boiling slowly in 95 c.cm. of water 1 gm., carbolic acid 5 c.cm. Differentiate in 0·25 to 0·5 p.c. iron alum. Counterstain with eosin and through alcohols and xylol to balsam. For a rapid technique Dobell's hæmatein is suggested, though the results are poorer. For this procedure fix in either Carnoy's or Gilson's fluids,

rinse in 70 p.c. alcohol. Mordant for at least 10 minutes in 1 p.c. iron alum, rinse in 70 p.c. alcohol, stain in 1 p.c. hæmatein in 70 p.c. alcohol, rinse in 70 p.c. alcohol. Differentiate in the iron alum, pass through the alcohols, dehydrate and mount.

G. M. F.

Gram Reaction in Crushed Yeasts.—H. A. Kemp (*Stain Technol.*, 1931, **6**, 53–6, 3 text-figs.). When thick smears of yeasts are dried, crushed between slides or cover-slips and stained by the Gram method, with aniline as a decolourizing agent, the appearances suggest a Gram-positive outer layer and a Gram-negative inner layer. G. M. F.

Non-Toxic Dyes and Dye-Resistant Bacteria.—J. W. Churchman (*Stain Technol.*, 1931, **6**, 57–63, 7 text-figs.). Some dyes are relatively innocuous for many typical varieties of bacterial life, and the degree of resistance of certain bacteria towards dyes, which are known to be highly toxic for many other species, is often great. Thus *Bacillus prodigiosus*, *B. anthracis*, and *Staphylococcus aureus* survive 48 hours exposure to saturated aqueous solutions of neutral red. All three organisms survived 21 days exposure to a 2 p.c. solution of neutral red, and *B. anthracis* survived 30 days exposure to this dilution of dye. The bactericidal action of both gentian violet and acid fuchsin is greatly increased by a slight rise of temperature. G. M. F.

The Handling of Chick Embryos.—F. B. Adamstone ("A Modification of the Technic of Handling Chick Embryos," *Stain Technol.*, 1931, **6**, 41–2). A modification of the usual technique is suggested whereby the embryo is spread out flat without delay in fixation. The embryo, with excess of blastoderm, is removed from the yolk and spread on a cover-slip in the usual manner in saline solution, and when the cover-slip is lifted, the edges of the blastoderm fold under. The cover-slip is immediately placed on a dry strip of paper in a clean container. The paper should be as broad as, but a little longer, than the cover-slip, so that the specimen may be lifted by the excess of paper. After remaining on the paper for a few minutes, the killing fluid is added, first a few drops directly upon the embryo, and then, in about a minute, enough to cover the chick. In an hour the specimen can be moved, without danger of loosening, to another container. G. M. F.

Cytology.

Hepatic Mitochondria after Prolonged Fasting.—J. F. Martin, P. Croizat and A. Guichard ("Le chondriome hépatique dans l'amaigrissement par jeûne prolongé (étude expérimentale)," *Bull. d'Hist. appl. de Physiol. et Path.*, 1930, **7**, 111–7, 2 figs.). Except for changes in form, there seems to be no direct relation between the mitochondria and the state of emaciation in rabbits.

G. M. F.

Mitochondria in the Submaxillary Gland of the Rabbit.—H. C. Moloy and I. H. Smith ("Mitochondria in the Submaxillary Gland of the Rabbit, with Particular Reference to Nerve Stimulation," *Anat. Rec.*, 1930, **45**, 377–92). The changes observed in the mitochondria, following stimulation of the chorda tympani and sympathetic nerves, over periods varying from 5 to 60 minutes, are described. The filamentous mitochondria of the resting homeochrome and trophochrome cells assumed rod-like and globoid forms after chorda-tympani stimulation; this was not the case after sympathetic stimulation. No quantitative variation in mitochondria was noticed after nerve stimulation, indicating that the mitochondria were not used up in the elaboration of secretion. G. M. F.

The Structure of the Oocytes of Eucalanus elongatus Dana and the Structure of the Female Genital Apparatus.—G. HEBERER ("Die Struktur der Oocyten von *Eucalanus elongatus* Dana mit Bermerkungen über den Bau des weiblichen Genitalapparates (Cytologische Mitteilungen, I)," *Ztschr. f. Wiss. Zool.*, 1930, **136**, 155–94, 2 pls., 17 figs.). *E. elongatus* has the advantage, from a cytological point of view, of being transparent. In the germinal vesicle many metabolic crystalloids are found, first as little needles, later of whetstone shape, and finally as spheroidal bodies, due to liquefaction. Rounded protein crystalloids cannot be distinguished from nucleoli. There is a continuous outward movement of nucleoli without perforation of the karyotheca. The yolk nucleus differentiates first into a ground substance and a granular mass made up of chondriosomes, which gradually disperse into the plasma. Formation of yolk now takes place, following migration of plastosome material from the nucleus, through the activity of the nucleolar apparatus. Oocytes of middle age differentiate an "inner nucleus." This, with the fact that the yolk nucleus and chondriosomes arise from nucleolar matter, shows that a migration of chromatin does not occur. G. M. F.

Quantitative Cytology: Variations of the Chondriome-Cytoplasmic Index in Elements cultivated in vitro, in Relation to Different Compositions of the Nutritive Substrate and to Variations in the Nuclear-Cytoplasmic Index.—A DEFRISE ("Ricerche di citologia quantitativa. Le varizioni degli indici condriomacito-plasmatici (c/ct, cp/ct), in elementi coltivati *in vitro*, in rapporto alla diversa composizione del substrato nutritizio, ed alle variazioni del rapporto nucleo-citoplasma (n/ct)," *Arch. f. exp. Zellforsch.*, 1930, **9**, 323–40, 1 fig.). Fibroblasts and myoblasts of the chick heart were cultivated in embryo juice and plasma. With continual growth of tissues, changes occurred in the composition of the medium. These were not measured, but changes in the ratios of the different cell parts to one another were. The ratio of chondriosome area to cytoplasmic area was more constant than the nuclear cytoplasmic ratio. The coefficient of variation, V = (0.100/average), of the chondriosome was smaller than that of the nucleus; chondriosome coefficient of variation was 190; nucleus 210. Addition of embryo juice to plasma caused a decrease in cell size and an increase in chondriosome size. G. M. F.

Different Forms of Mesenchymal Cells in Cultures of Tissue in vitro.—I. FAZZARI ("Sulla forma differente delle celluli mesenchimali dei varii organi nelle culture dei tessuti 'in vitro,'" *Arch. f. exp. Zellforsch.*, 1930, **9**, 359–83, 2 pls.). Mesenchymal cells from various organs of a single embryo differ, each organ possessing a characteristic cell form. This specificity continues, even after a series of transplants, but diminishes when the proliferation of the cells in the culture increases, because of the addition of embryonic extract. G. M. F.

The Vacuome and Golgi Apparatus in the Acinar Cells of the Pancreas of the Rat.—H. W. BEAMS ("Studies on the Vacuome and the Golgi Apparatus in the Acinar Cells of the Pancreas of the Rat," *Anat. Rec.*, 1930, **45**, 137–61, 1 pl.). The so-called vacuome in the acinar cells of the pancreas of the rat, following a subcutaneous or intraperitoneal injection of a saturated aqueous solution of neutral red, appears as isolated granules and vacuoles, ranging in volume from rather larger to rather smaller than the mature zymogen granules. The vacuome does not blacken with the osmic acid methods commonly used to demonstrate the Golgi apparatus, unless previously stained with neutral red. Intravitam stained neutral-red preparations, followed by modified Kopsch's technique, show bodies

of the same size and distribution as in the neutral-red preparations. The bodies appear black, or with blackened boundaries. The Golgi apparatus in the acinar cells of the pancreas is a typical network. Intravitam stained neutral-red preparations, followed by the modified Kopsch's technique, disclose the Golgi apparatus and the vacuome side by side in the same cell; the elements of the vacuome may be embedded among the strands of the Golgi apparatus. The author believes that these observations show that the so-called vacuome and the Golgi apparatus are two distinct substances in the acinar cells of the pancreas, and that the Golgi apparatus is not an artifact of reduced osmium tetroxide in the periphery, and spaces between the bodies of the vacuome. G. M. F.

The Geometrical Principle of "Mœbius Rings" in Chromosomal Behaviour at the Heterotypic Mitosis and its Significance in Relation to Inheritance and Tumour Formation.—W. JACOBS ("Das geometrische Prinzip der 'Moebiusringe' im Chromosomenmechanismus der heterotypischen Mitose und seine Bedeutung für Vererbung und Geschwulstentstehung," *Ztschr. f. Wiss. Biol., Abt. D: Roux Arch. Entwicklungsmech*, 1929, **120** (Festschr.), 56–191, 64 figs.). This paper represents an ingenious attempt to explain the complex arrangement of chromosomes that occurs in crossing over. A "Moebius ring" is obtained by joining the ends of a strip of paper that has been twisted, for example, 180°. By dividing a "Moebius ring" in the median line there is obtained, not two rings, but a twisted loop that has double the length of the original ring. The principle of the "Moebius ring" can account for the arrangement of chromosomes in the heterotypic mitosis in numerous cases. The chromosomes in the maturation divisions of Salamandra, described by Flemming and others, are very clear in this respect. Also, such complicated cases as those found in the maturation divisions of Oenothera can be accounted for by the Moebius principle. Here the chromosomes form chains of linked rings. Moebius rings twisted 360°, or every even multiple of 180°, will form such figures when divided in the median line. Specially complicated cases, such as are seen in the pollen mother-cells of *Eucharidium concinnum*, are also imitated by the author's models. The mechanism of crossing-over can be understood on the basis of these conceptions, an exchange between the chromosomes being possible at the formation of the twisted loop. The mass of chromatin is doubled during the growth phase of spermatogenesis. Corresponding to this, cell and nuclear size in the spermatocyte 1 is double that of the spermatogonium. Malignant cells may arise through mutations caused by cross-overs in abnormal somatic divisions akin to heterotypic divisions, and based upon the Moebius principle. G. M. F.

Mitochondria and Nerve Stimulation in the Thyroid.—I. H. SMITH and H. C. MOLOY ("The Effect of Nerve Stimulation and Nerve Degeneration on the Mitochondria and Histology of the Thyroid Gland," *Anat. Rec.*, 1930, **45**, 393–406, 2 pls.). A series of nerve-stimulation and nerve-section experiments were performed on the thyroid of the rabbit, with the object of producing mitochondrial alterations indicative of thyroid activity or inactivity. No changes were observed in the mitochondria of the epithelial cells of the thyroid, either morphologically, quantitatively or topographically, after stimulation or section either of the cervical sympathetic or of the vagus and its branches. G. M. F.

Cytoplasmic Structures and the Golgi Apparatus in Cells Cultured in vitro.—J. ZWEIBAUM and A. ELKNER ("Les structures cytoplasmatiques et l'appareil de Golgi dans les cellules cultivées in vitro," *Arch. f. exp. Zellforsch.*, 1930, **9**, 419–46, 3 pls., 2 text-figs.). After from four to six days osmic impregnation

in a plasma medium, fibroblasts and epithelial cells of the chick embryo and rabbit fibroblasts show the Golgi apparatus under quite different forms, independent of the degree of flattening of the cells. In a liquid medium (Ringer's solution or serum) the cytoplasmic structures do not undergo " osmification." Only very rarely, and after long " osmification " (up to four weeks), are blackened structures found at the active pole of the cells. These differences depend on physical conditions. Detailed analysis shows that the same structures appeared at the active pole of chick fibroblasts, as in the rest of the cytoplasm, viz.: (1) fat drops (very rarely); (2) chondriomites and, more numerously, chondriosomes; (3) vacuoles and grains of neutral red, which often occur in pronounced accumulations, and (4) uncoloured vacuoles (very rarely). The Golgi apparatus is concluded to be an artifact obtained by the blackening of known cytoplasmic structures. G. M. F.

Fibril Formation in Explanted Connective Tissue.—F. H. Ludwig (" Beobachtungen am explantierten Bindegewebe mit besonderer Berücksichtigung der Fibrillenbildung," *Arch. f. exp. Zellforsch.*, 1930, **9**, 384–401, 7 figs.). Tissue cultures from the hearts of chick embryos, seven to fourteen days old, in fowl embryonic extract, and, from the liver of a three-weeks-old dog, in dog blood-plasma, were studied, living and fixed. In living cultures the formation was observed of very delicate protoplasmic spurs and stronger protoplasmic bridges from the cells sprouting from the explant. Primitive fibrillæ and chondriosomes could not be demonstrated in the living cultures by vital staining. Fixed preparations showed a distinct fibrillar formation in the ectoplasm, the fibrillæ being thread-like and sharp in contour. In rat blood-plasma cultures, no fibres resembling primitive fibrillæ could be seen after eight days observations. G. M. F.

Endothelium and De-differentiation in vitro.—E. S. Horning and K. C. Richardson (" On the Cytology and Behaviour of Endothelium during the Process of De-differentiation *in vitro*," *Arch. f. exp. Zellforsch.*, 1931, **10**, 488–500, 3 pls.). The *in vitro* cultivation of embryonic liver gives four types of migrating cells, liver parenchyma, endothelial cells, free histiocytes and mesothelium from the peritoneum of the liver. Of these cells, the endothelial, derived from the sinusoids of the liver taken from embryos of short incubation periods, de-differentiate into typical mesenchyme cells after periods *in vitro*, which vary according to the initial age of the explant. Experiments on the nature of this process of de-differentiation indicate that recently differentiated cells, in an embryonic organ or tissue, undergo a period of " unfixed " differentiation before they finally become resistant to any change in their cytological characters. If cells in this latent period of " unfixed " differentiation are explanted *in vitro*, they retrogress to a primitive stage after short periods of incubation. Cells near the conclusion of this period take longer to de-differentiate, and those which are of still greater age entirely fail to show this transformation, irrespective of prolonged incubation *in vitro*. The process of de-differentiation in cells explanted in their unfixed condition, and which apparently possess an inherent transient mechanism allowing them to revert to a primitive condition, may be ultimately affected by variations in metabolism, as suggested by Childs. G. M. F.

Drosophila and Ultra-Violet Rays.—R. Geigy (" Action de l'Ultra-Violet sur le pôle germinal dans l'œuf de *Drosophila melanogaster*. Castration et mutabilité," *Revue Suisse de Zool.*, 1931, **38**, no. 10, 187–288, 5 pls., 21 text-figs.). Part I of this paper deals with the embryonic development of *Drosophila*, the formation and destination of the polar cells, the morphology and organization of

the male and female genital systems, and the structure of the gonads in the larvæ, pupæ and adults. Part II deals principally with experimental castration, the destructive effects of ultra-violet rays on eggs exposed to their action, the subsequent effect of castration on the morphology of the genital apparatus, and the histological structure of sterile gonads. Part III is concerned with the penetrative power of ultra-violet rays and their application to genetics and mutation in irradiated subjects and controls. The following abstract is largely taken from the author's summary. The author has followed, in the egg of *Drosophila melanogaster*, the formation of the sexual elements, or polar cells, in the evolution of the male and female gonads through the larval, pupal and adult stage. He was able to identify, in the testicle, the following group of cells: the germinal cells, the parietal cells, the cells of the primitive ducts (which probably also produce the nutrition cells). As the components of the ovary: the germinal cells, the cells of the mesenchyma, and the epithelial cells. It has been found possible, by experimental irradiation of the posterior pole of the egg with ultra-violet rays, to prevent, in the cleavage stage, the formation of the sexual elements. Irradiation of the already formed group of polar cells in the blastomere stage very easily brings about, within the blastoderm tissue, an irreparable injury which usually causes the death of the developing embryo. In other experiments of the same kind, however, where sublethal doses were used, sometimes unilateral and sometimes bilateral castration in both males and females resulted. In individuals which had suffered total castration, both gonads present a rudimentary appearance; in case of unilateral castration the gonad of one side only is reduced, while the other genital gland is functional and, in size, is often either above or below the normal dimensions. Histological examination of the testicles of specimens which have suffered either total or unilateral castration shows the presence of all the cells, with the exception of the germinal cells, which are entirely absent. Consequently, it is thought that this indicates that these latter cells are the only descendants of the polar cells. In the author's opinion it is certain that the other cellular components of the gonads have a different origin; most probably mesodermic. The normal and perfectly independent development of the other constituents of the gonads, as well as of the rest of the genital apparatus, and the morphology and physiology of the secondary sexual characters, in the absence of polar cells, prove the precocity of somatic and sex differentiation in the *Diptera*, and denote, once more, in the author's opinion, the absence of sexual hormones. Irradiation of larvæ and imagoes of *Drosophila*, with the object of inducing genetic variation comparable with that obtainable with X-rays, gave negative results. This is thought to be due to the lower penetrative power of ultra-violet rays. By a non-lethal, shorter exposure of the sexual elements of the egg, a distinct increase of mutability in the descendants has been shown to occur. M. E. M.

Histology.

The Ductless Glands of Alligator mississippiensis.—A. M. Reese (*Smithsonian Miscell. Collect.*, 1931, **82**, no. 16, 1–14, 3 pls.). The author describes the anatomy and microscopical structure of the adrenal bodies, thyroid and parathyroid glands, thymus gland, spleen and pituitary body in the alligator. The adrenals are yellowish, elongated bodies between and anterior to the kidneys; they are closely associated with the anterior two-thirds of the gonads and with the aorta and the postcaval vein. The cortex and medulla are not sharply segregated into two regions, as in mammals, the chromaphil material appearing as scattered groups of cells, chiefly in the interspaces between the strands or columns

of the cortex. These chromaphil cells are easily distinguished from the cortical cells in material fixed in chromium salts, since they become coloured from brown to bright yellow and stand out in strong contrast to the paler cortical cells. The thyroid gland in the alligator is a small bilobed structure lying across the ventral surface of the trachea, at the level of the auricular end of the heart. The microscopic structure presents no unusual features. The parathyroid consists of a small body closely adherent to the thyroid gland, and several small spheroidal bodies situated on each side of the neck, near, or even embedded in, the thymus glands. They consist of degenerate alveoli and "Hassall's corpuscles." The thymus is long, narrow, and inconspicuous, lying against the muscles of the neck, lateral and dorsal to the œsophagus, with its enlarged posterior end near the main blood-vessels of the heart. The gland tissue shows but little difference between the outer cortical region and the central or medullary region, such as is seen in higher vertebrates. In both regions numerous corpuscles of Hassall may be seen. The spleen in the alligator has the appearance and location seen in other animals, but is relatively of rather small size. One of the characteristics of this organ in the alligator is the almost complete absence of trabeculæ extending from the capsule towards the centre of the gland. The pituitary body is carefully described, and has the structure characteristic of higher vertebrates, with well-marked nervous, intermediate, and glandular regions. There is no vestige of the hypophysial cleft in the adult animal, but the infundibular cavity is large, and extends well down the hypophysial stalk. The microscopic structure presents no peculiarities.

M. A.

Embryology, Heredity, etc.

The Determination of Sex in Batrachians.—J. Piquet ("Détérmination du sexe chez les batrachians," *Rev. Suisse de Zool.*, 1930, **37**, no. 6, 173–281, 1 pl., 49 text-figs.). In Batrachians the phenomena of intersexuality and of sex-reversal are common, and it is suggested that each of the sexes possesses the potentialities of both sexes. It is assumed that, instead of a single pair of factors determining sex, there are two pairs of factors. The male would have the constitution MMFf and the female MMFF. If it is accepted that the factors M and F have different valencies in different races, an explanation of the differing results obtained when certain races are crossed can be arrived at. The following points are studied in the present paper, both in *Bufo vulgaris* and *Rana temporaria* :—The normal evolution of the gonad in both sexes ; the action of temperature on the differentiation of the gonad. Three groups of eggs were reared at temperatures of 10°, 20° and 25°. (*a*) At 10° : In *R. temporaria* all the gonads at first passed through an ovarian stage, but half of these were transformed to testes, so that the final result was 50 p.c. males and 50 p.c. females. Hence, low temperature tends to produce the female type of gland upon which, eventually, the genetic constitution imposes the male type. In *Bufo vulgaris* there is an excess of females as a final result. (*b*) At 20° : In *R. temporaria* an excess of males is obtained. These are, in part, true genetic males, the others have passed through an ovarian phase to become false males, i.e., genetic females who have acquired testes. In *B. vulgaris* the groups consist of nearly equal numbers of males and females, of which the gonads show a normal evolution. This temperature is thus practically neutral for this animal. (*c*) At 25° : The effect obtained at 20° is more marked, so that practically 100 p.c. males are obtained. In *B. vulgaris* development is much accelerated and sexual differentiation is precocious. There is an excess of males due to transformation from females. A careful study was made of the gonads at all stages during these sex reversals, and the following conclusions were arrived at: The

modifications in the sexual phenotype caused by temperature are parallel with changes caused in the speed of development; this is retarded by cold and much accelerated by heat. The phenomena of these sex reversals consist, essentially, in a primary degeneration of the ovarian elements, followed by an evolution of the primordial germ cells towards spermatogenesis. The formula elaborated by Witschi—"ovary peripheral, testis central"—does not hold in all cases; frequently this arrangement of tissues is reversed in a gonad which is in the process of transformation. The gonad of *B. vulgaris* shows three successive stages in differentiation, constituting the pro-, meso- and metagonads. It is only the metagonad that shows response to different temperatures. M. A.

Sex, Species and Race Discrimination by Manoilov's Methods.—CHARLES E. ABROMAVICH and W. GARDNER LYNN (*Quart. Rev. Biol.*, 1930, **5**, 66–78). The authors give an account of Manoilov's methods by means of which races, sexes, and species can be differentiated. The methods are described in detail, and consist of adding certain chemical reagents to blood preparations, and they differ according to the problem to be investigated, whether sex, race or species. The chemical significance of the tests is fully discussed. Various workers have pursued the problem of blood differences, using Manoilov's methods, and in many cases the results are conflicting. With regard to the method for the differentiation of sexes, it has been shown that it is, to a certain extent, a measure of organic material present, a test involving a very variable factor, since the amount of organic material is known to vary in an individual, e.g., with fluctuations in reproductive activity. Other investigations into the chemical nature of the Manoilov tests indicate that they are a measure of rates of oxidation, and this theory would explain the contradictory results obtained since the rates of oxidation are correlated with metabolism, and by modifying the metabolic level one could obtain, at one time, a test indicating a male, and, at another time, one indicating a female; or at one time a test indicating a monkey, at another a human being. A good bibliography is given of the work bearing on the subject. M. A.

Sex Linkage in Man.—C. B. DAVENPORT (*Genetics*, 1930, **15**, 401–44). In this paper the information which has been collected regarding the best-known sex-linked traits in man is reviewed and analysed. The different sex-linked traits show differences in genetic behaviour. Red-green colour-blindness behaves like a typical sex-linked trait. Hæmophilia is exceptional, in that all duplex recessive female zygotes die. Optic nerve atrophy appears in several genetic types, only one of which is typically sex-linked, and in that type daughters of affected males rarely have affected sons. Female conductors form a genetic stolon from which affected males bud off. Also the incidence of optic atrophy in females is unexpectedly high, probably due to the expression of the trait in the heterozygous condition. Other sex-linked traits are rare, or less carefully analysed: hypoplasia of brain substance (Mersbacher), night blindness (or hemeralopia), some strains of myopia, pseudohypertrophic muscular paralysis of Gowers, and megalocornea. To these traits wanderlust or nomadism may be added. Still less documented are coloboma, nystagmus, microphthalmia, ichthyosis, webbed toes, toothlessness, and deficiency in sense of smell. Since two sex-linked characters occurring in the same family should show linkage in inheritance, such "double-recessives" were looked for. In a hæmophilic family (Gross) colour-blindness was found, but the hæmophilia appeared to be of such recent origin that linkage of its gene with that of colour-blindness could not be studied. A family containing double recessive individuals (Dörr) has been described. It is probable that the concurrence in

some families of night blindness and myopia is due to sex-linkage. Crossing over between the genes of night blindness and myopia appears in the family described by Newman, and more irregularly in a few others. Finally, the need of a repository of family histories to provide, in time, documentary evidence of traits of members of earlier generations—especially important in sex-linked traits—is stressed.

M. A.

La Notion de Territoire et les Excroissances Digitales de Crapaud.—K. Ponse (Wilhelm Roux's *Archiv. fur Entwicklungsmechanik der Organismen*, 1930, **121**, Heft 4, 755–69, 13 text-figs.). The male genital hormone conditions the phenomenon of growth of the nuptial pad in frogs and toads. It has been shown that the transplantation of a testis into a female toad causes the growth of the nuptial pads, and in exactly the same place as in the male, showing that this action of the male hormone is definitely localized. The object of the experiments described was to see if other tissues placed in identically the same conditions of vascularization and innervation acquire the same potentialities of regeneration. To do this the nuptial pad was replaced by a piece of skin from another part of the body, and the nuptial pad transplanted to various parts of the body. An endeavour was made to find if the specificity of the nuptial pad tissue was localized in the chorion or in the Malphigian layer of the epidermis. It was found that the nuptial pad transplanted to other parts of the body showed no regression, while the skin transplanted to the fore limb remained unchanged also. The cells which constitute the nuptial pad have, therefore, a special qualitative constitution, so that they react to the male hormone in the same way, whatever their position, and even when only a mere fragment of their total number. After mutilation and removal of the fore limb, a new limb is regenerated which, while not perfect as to muscles and skeleton, possesses an area of skin which is sensitive to the action of the male hormone, and its abnormal position is only a consequence of the aberrant type of regeneration. The localization and even the definition of the territory of the nuptial pads appear to be the work of auto-differentiation, the seat of which may be the palm of the hand in the normal member or the regenerating blastema in a transplant.

M. A.

On the Pregnancy Rate in the Lactating Mouse and the Effect of Suckling on the Duration of Pregnancy.—L. Mirskaia and F. A. E. Crew (*Proc. Roy. Soc., Edin.*, 1930, **51**, pt. I, 1–7). It has been shown by these authors that, when the litters are removed at birth from adult female mice, the rate of fertile to infertile matings, i.e., the pregnancy rate, immediately following parturition, is not less than that which is characteristic of the stock as a whole, viz., 85 p.c. In this paper the frequency of pregnancy following post partum mating in the suckling mother is examined, both primaparæ and multiparæ being used. The pregnancy rate of primaparæ suckling their young was, in this experiment, 24·1 p.c.; that of multiparæ suckling their young, 50 p.c. It is suggested that this difference between puberal and adult groups is that a certain level of somatic maturity is required for full reproductive activity. In all cases the duration of pregnancy was prolonged, this extension of the gestation beyond the normal 19 days varying from 6 days to 16 days. The degree of prolongation could not be related to the number of young in the uterus or to the number suckling. The authors hold the view that prolongation of gestation in the suckling mother is due to an insufficiency of the hormone or hormones responsible for the inception and maintenance of the state of pregnancy, and that the variations in the degree of prolongation are reflections of individual differences in respect of production of

these hormones. The figures presented in the paper suggest that there is a relation between the number of corpora lutea present and the degree of prolongation of pregnancy, the more corpora lutea the shorter the pregnancy. Hence the delayed implantation of ova and the prolonged pregnancy are presumably due to inability on the part of the corpus luteum to cater adequately for implantation and lactation synchronously. M. A.

Mollusca.

The Ascending Movements of Physa.—M. Neyret ("Les mouvements ascensionnels de la Physe," *Bull. Soc. Nat. Acclimat. de France*, 1930, **77**, 93–5). The normal specific gravity of Physa is less than that of water as a result of the air in its pulmonary cavity. By secreting an invisible mucous filament, which remains attached to the bottom, the gastropod can ascend or descend in the water. In the presence of danger it expels the air and falls by its own weight to the bottom. A similar phenomenon is not recorded in Limnæa or Planorbis. G. M. F.

Arthropoda.

Insecta.

Five New Microlepidoptera from Africa.—G. Audeoud ("Cinq microlepidoptères africains nouvellement decrits dans la collection Audeoud," *Mitteilungen der Schweiz. Entomol. Gesell.*, 1930, **14**, Heft 7, 105–6, 1 pl., 5 figs.). The author, in this paper, gives further notes on the five new species which have been previously described by E. Meyrick in *Exotic Microlepidoptera* (vol. 3, fasc. 17–18), together with illustrations of the separate species. M. E. M.

A New Species of Lepidoptera.—N. D. Riley ("*Mylothris audeoudi*, n. sp.," *Mitteilungen der Schweizer. Entomol. Gesell.*, 1930, **14**, Heft 7, 107–8, 1 pl., 4 figs.). The title of this paper is self-explanatory. Both males and females are described. M. E. M.

Biology of Simulium.—Yi Fang Wu ("A Contribution to the Biology of *Simulium* (Diptera)," *Papers Mich. Acad. Sci., Arts and Letters*, 1930, **13**, 543–99). New contributions not easily summarized have been made to the general biology of the different stages of *Simulium*, and are presented in pt. 1 of this paper. For the first time an observational and experimental study has been made of the running-water habitat of *Simulium*. The current rates in the natural habitats were measured and found to be from 0·56 to 2·75 feet per second, or even higher where larvæ were attached in more or less vertical falls. By means of transplantation and current experiments in the natural habitat, numerous observations have been made regarding the minimum current rate for larvæ in different streams; the minimum current rate for larvæ in the same stream; the highest current rate obtained in trough experiments; the food factor; the problem of oxygen supply, and the effect of its concentration, etc. M. E. M.

North American Saw-flies.—H. H. Ross ("Saw-flies of the Sub-Family *Dolerinæ* of America North of Mexico," *Ill. Biol. Mono.*, 1929, **12**, 1–116, 6 pls.). In this paper the attempt is made to apply to the Nearctic species of the *Dolerinæ* the same critical examination of the genitalia which has been accorded the Palearctic forms. The masking of several species under the same colour, and the assumption of several colour combinations by the same species, have given rise to many homonyms and synonyms. On account of the complexity which has thus arisen, it has seemed advisable to select neotypes for the species of which the types cannot

be found. This the author has found a difficult problem in many cases, but with regard to each one the course has been followed which will permit of retaining the largest number of names already in the literature. In some cases the saws of the females are characteristic of the species, in others the sheath, but in others, again, neither of these are of use except for complexes within the group, and in these cases an aggregate of other characters have been used. In pursuing this revision, material has been assembled from all the major collections in North America, and from as many as possible of the smaller ones. Several thousands of specimens have been examined from a great many parts of the country, so that the distribution given for the various species should have some significance. M. E. M.

The White Flies of India.—K. SINGH ("A Contribution towards our Knowledge of the *Aleyrodidæ* (White-flies) of India," *Mem. Dept. Agric., India*, 1931, **12**, nos. 1 and 2, 1–98, 37 pls.). The present work deals with the family mainly from a systematic point of view, and 44 species are described, of which 23 are new. Systematic work forms the bedrock on which an economic structure is erected. A pest must be definitely recognized before any investigations on it can be undertaken. Notes on the biology have been appended whenever possible, and parthenogenesis has been observed to take place in a few species. The species have been described at some length, as advised by Dr. Quaintance, the authority on the family. For the convenience of reference, a list of species previously recorded from India and Burma, but not included in this paper, has been given on pp. 92–3. M. E. M.

A New Injurious Coccid.—F. LAING ("A New Coccid Injurious to Fruit Trees in Baluchistan," *Mem. Dept. Agric., India*, 1931, **12**, no. 2, 99–100, 1 pl.). Amongst a small collection of *Coccidæ* and *Aphididæ* collected from various fruit trees by Mr. C. S. Misra, at Quetta, towards the end of May, 1929, and submitted to the author for examination by the Imperial entomologist, Mr. T. Bainbrigge Fletcher, was what appeared to be a new species of *Aspidiotus*, a description of which is here given. The scales were encrusting the bark and, except that they were whiter in colour, appear much like *A. perniciosus* Comst. The pygidial characters are amply distinct, however, from that species. This new species is described under the name *Aspidiotus prunorum*, sp. n. M. E. M.

New Wasps.—A. VON SCHULTHESS ("Neue Vespiden (Hym.)," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1931, **15**, pt. 2, 49–52, 3 text-figs.). Descriptions are given in Latin of the following new species: Eumenidinæ; *Nortonia enslini*, n. sp.; *Rhynchium (Pararhynchrum) mamillatum*, n. sp.; Vespinæ: *Icaria shestakomi*, n. sp. M. E. M.

New Geometrids from Western China.—E. WEHRLI ("Neue Geometriden aus West-China (Lep. Het.)," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1931, **15**, pt. 2, 52–4). Descriptions are given in German of the following species: *Gnophos hypochrysa* n. sp. (male and female); *Gnophos leptogramma* n. sp. (female); *Heterostegane thibetaria* n. sp. (male and female). M. E. M.

A New Geometrid from Switzerland.—F. NAIER ("Eine neue Geometridæ für die Schweiz," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1931, **15**, pt. 2, 54–5). This paper consists of a note on the species *Gnophos asperaria* Hb. M. E. M.

Two New Beetles.—F. Ohaus ("Zwei neue Rutelinen (*Col. Lamell.*) aus dem Basler Naturhistorischen Museum," *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 1930, **15**, pt. 1, 17–9, 2 text-figs.). Descriptions in Latin are given of the following species: *Anomala sarasinorum* n. sp. (male); *Anomala phimotica* n. sp. (male and female). M. E. M.

Shock Reactions in Dineutes.—L. B. Clarke ("Some Factors Involved in the Reaction of Insects to Changes in Luminous Intensity; Shock Reactions in *Dineutes assimilis*," *Journ. Experimental Zool.*, 1931, **58**, 31–41, 1 text-fig.). Specimens of *Dineutes* with one eye covered, when placed in a beam of light on a suitable background, perform circus movements for a time, then go in a straight path across the beam. If, after the insects are orientated, the light is rapidly increased, they turn sharply from the source; if it suddenly decreased, they turn sharply towards the source. These responses depend upon light reflected from the background. The elimination of circus movements is probably due to light adaptation progressing to such an extent that some of the ommatidia of the posterior portion of the eye are no longer stimulated after orientation. If the intensity is increased rapidly, some or all of these ommatidia are probably stimulated, and the insect turns from the source of light. If the intensity is decreased rapidly, more of the ommatidia probably cease to be stimulated, and the insect turns in the opposite direction. M. E. M.

Insects and Climate.—B. P. Uvarov ("Insects and Climate," *Trans. Entom. Soc., London*, 1931, **79**, pt. 1, 1–247, 53 text-figs.). This large paper is in the nature of a review of the literature, with comments by the author. Its composition is as follows:—Part 1: Physical factors of insect life; (*a*) Heat; (*b*) Humidity; (*c*) Other climatic factors; and (*d*) Combinations of several factors. Part II: Weather, climate and insects; (*a*) Relation of weather to the activities of insects; (*b*) Daily and annual cycles; (*c*) Climate and distribution; (*d*) Effect of climate on abundance; and (*e*) Climate and weather in economic entomology. The paper also includes an extensive bibliography, index to authors, and a good subject index. The author has here given us an excellent summary of our present knowledge. Economic entomologists of the present day are no longer satisfied with merely recording the outbreaks of insect-pests and with devising means for their control. They realize more and more that their chief aim and highest ambition must be to foresee and to prevent outbreaks. In order that they may be able to do so, all conditions accompanying a cause in outbreaks must be thoroughly investigated and elucidated; in other words, the epidemiology of insect-pests must be the central problem of economic entomological research, which should be carried out from the ecological point of view. The ecological conception of economic entomology consists in the recognition of the injurious insects as an integral part, and even as a product, of its environment. About 1,150 papers and books, written in 11 different languages, have been consulted in this work, and although the author does not lay claim to an exhaustive treatment of the subject, he gives us, at least, an invaluable summary. M. E. M.

Respiration of Insects.—V. B. Wigglesworth ("The Respiration of Insects," *Biol. Rev. and Biol. Proc. Cambridge Phil. Soc.*, 1931, **6**, no. 2, 181–220). This paper is a review of our present knowledge of the physiology of respiration in insects. The following is the author's summary:—The review covers the ground of external and internal respiration in insects, but deals neither with quantitative changes in metabolism, nor with the intimate processes of oxidation in the tissues.

The general anatomy and histology of the tracheal system are described. The form of the tracheæ and their mode of ending in the tissues are extremely varied in different insects and in different organs. The question whether tracheal endings contain fluid or air, and the problem of what forces keep the larger branches filled with gas, are discussed in detail. The embryological development of the tracheal system and the nature of the " spiral thread " are briefly considered. The exchange of gases in the tracheal system is effected primarily by diffusion. This is modified by opening and closure of the spiracles (" diffusion control ") and mechanical ventilation of the larger tracheal branches (" ventilation control "). The mechanism of tracheal ventilation is discussed at length, including the part played by the air-sacs and the question whether there is a directed stream of air through the tracheal system. The respiratory movements are controlled by nerve centres, variously situated in different insects, and these centres may be stimulated either by oxygen want or by carbon dioxide excess. The relative importance of the spiracles and the skin respiration, especially in the elimination of carbon dioxide, is discussed. Under the respiration of aquatic insects the functions of the " blood-gills," " tracheal gills " and " cuticular gills," are reviewed, and the problems connected with the " hydrofuge " structure of aquatic insects, and the air stores which they carry, are considered. The respiration of parasitic insects presents many parallels with that of aquatic forms. The part played by the blood of insects as a carrier of oxygen is discussed in detail. M. E. M.

Lesser Beetle Pests of the Olive.—G. Del Guercio (" I punteruoli piu importanti dell'olivo," *Redia, Giornale di Entomolgia*, 1931, **19**, 1–74, 35 text-figs.). The author gives an account of the less important beetle pests of the olive, including *Phlœotribus scarabœoides* Bern. (Punteruolo conume), *Phlœotribus oleiphilus* del Guercio (Punteruolo nuovo), *Hylesinus oleiperda* Fabr. (Ilesino dell'Olivo), *Hylesinus fraxini* Fabr. (Ilesino del Frassino), *Comesiella sicula* del Guercio (Comesiella dell'Olivo). Descriptions are given of the morphology and biology of each of these insects, the type of damage they produce, and the climatic and other factors which favourably and adversely affect the species. M. E. M.

Dermaptera of Southern India.—A. Borelli (" Dermaptères de l'Inde meridionale," *Rev. Suisse Zool.*, 1931, **38**, no. 10, 289–308, 12 text-figs.). A large number of species new to science are described. M. E. M.

Biology of the Haliplidæ.—J. R. Hickman (" Contribution to the Biology of the *Haliplidœ* (*Coleoptera*)," *Ann. Ento. Soc. Amer.*, 1931, **24**, no. 1, 129–42). The literature contains several scattered references to the biology of *Haliplidœ*. Except for the work of Matheson and Wilson on a few species, no extensive study of these beetles in America has been made. The author here publishes his observations on the biology of *Haliplidœ* which have accumulated in the course of experimental work. Culture methods were developed for keeping the imagoes alive in the laboratory at all times of the year, and for rearing these beetles from the egg through all of the developmental stages. Imagoes and larvæ of the three species of *Peltodytes* and of *Haliplus immaculicollis* feed upon filamentous algæ, especially *Spirogyra*. *H. cribrarius* and *H. triopsis* feed upon *Chara* and *Nitella* in both mature and immature stages. There is definitely one generation in the summer, and evidence of an autumn generation that extends over to the following spring. Both imagoes and larvæ spend the winter in the water, and show the same activities as during the summer. The duration of the third larval instar can be prolonged for nine months, or longer, by keeping the larvæ in water and preventing them from reaching soil in which to pupate. M. E. M.

Honeydew Reflexes.—E. A. ANDREWS ("Honeydew Reflexes," *Physiol. Zool.*, 1930, **3**, no. 4, 467–84). Without any external stimulus, certain aphids, the membracids *Thelia bimaculata* Fab. and *Vanduzea arquata* Say, as well as the tulip tree-scale, will, from time to time, project honeydew from their bodies by a violent muscular effort. Certain external mechanical stimuli may lead to the same result. However gentle, reiterated stimuli lead to a modified result; the drop of honeydew is presented and held in a sort of basket till removed by outside forces, or else withdrawn back into the body again. The commonly accepted conclusion that ants, by movement of their antennæ upon the honeydew producer, elicit the modified flow of honeydew, becomes demonstrated by the facts that, firstly, when ants attend these insects, the intervals between presented drops are shorter than the intervals between spontaneous projections; and secondly, that various artificially applied mechanical stimulations induce the same modified presentations of honeydew. The symbiotic adjustment of these sucking insects to the ants is due to their reflexes having become adjusted to slight external mechanical stimuli applied by the ants. The drinking of honeydew is not necessarily foreseen by the ant, according to this author. Certain sugar flies actually apply mechanical stimuli to some membracids by violent movements of their forelegs, and thus liberate and profit by the modified reflexes. M. E. M.

Gamic and Parthenogenetic Aphids.—A. F. SHULL ("Order of Embryonic Determination of the Differential Features of Gamic and Parthenogenetic Aphids," *Ztschr. für induktive Abstammungs und Vererbungslehre*, 1930, **57**, pt. 1, 92–111, 1 text-fig.). Gamic and parthenogenetic females of the aphid species *Macrosiphum solanifolii* differ in the colour of their antennæ, colour, size and sensoria of posterior tibia, colour of body, and several features of the reproductive system. When the offspring of winged females are gradually changed from gamic to parthenogenetic females, these differential features do not all change at the same time, nor at the same rate. The earliest offspring to show any change, during such a period of transformation, show the change in the antennæ and hind tibia. Only later offspring show changes in the body colour and reproductive system. Within the reproductive system the earliest change to take place in successive offspring is the loss of the collateral glands and seminal receptacle; later offspring show various modifications of the ovaries. If the order of change in successive offspring is determined by the times in embryonic development at which the fate of the various structures is decided, as has been postulated for intersexes, the order of embryonic determinations must be the reverse of the order of change in successive offspring. Consequently, if the transformation can be effected in the opposite direction, that is, from the parthenogenetic to gamic, the same order of determination and the same order of change in successive offspring should prevail, though each individual feature should be altered in the opposite direction. Contrary to this expectation, when winged females whose offspring have been changed from gamic to pathenogenetic by high temperature are then returned to low temperature, so that their offspring gradually change back to the gamic type, this latter change takes place in a different order. The early offspring show changes in the body colour and reproductive system, while changes in the antennæ and hind tibiæ begin later. What evidence there is relative to the parts of the reproductive system indicates that the collateral and seminal receptacle are not changed before the ovarioles, in the succession of offspring. The author gives three possible explanations of this reversible order of change. The first of these explanations permits, but does not necessarily favour, the assumption that time of determination of structures decides the composition of intermediates. The second

explanation assumes that time of determination is the deciding factor. The third explanation is opposed to the time-of-determination hypothesis. M. E. M.

Sense Organs of Coleoptera.—N. E. McIndoo ("Tropisms and Sense Organs of Coleoptera," *Smithsonian Misc. Coll.*, 1931, **82**, no. 18, 1–70, 2 pls., 19 text-figs.). This paper is a continuation of a series of studies dealing with the tropisms and sense organs of insects. It forms a complement to the writer's former paper entitled "Tropisms and Sense Organs of Lepidoptera," 1929, *ib.*, vol. 81, no. 10, 1–59), and contains practically no information found in the former paper, although, of course, the information which deals with the *Coleoptera* alone is of a similar nature. In order to obtain comparative results which could be treated statistically, new technique and apparatus have been devised by the author, and the more important experiments have been frequently repeated under controlled conditions. M. E. M.

Respiration of the Haliplidæ.—J. R. Hickman ("Respiration of the Haliplidæ (Coleoptera)," *Papers of Mich. Acad. Sci., Arts and Letters*, **13**, 277–89, 3 text-figs.). The imagoes of the *Haliplidæ* must come to the surface of the water for their air-supply even when the temperature is about 0° C. Normally, they take in air by way of the tip of the abdomen, although they can live if permitted to obtain the air only by way of the posterior coxal plates. The air-store retained by the posterior coxal plates has both respiratory and hydrostatic functions. The duration of the submerged interval is dependent upon the nature of their activity. The author demonstrates these findings partially by means of experimental physical apparatus used in conjunction with the living beetles. M. E. M.

Life-History of the Water-Strider, Rheumatobates rileyi Berg.—J. K. G. Silvey ("Observations on the Life-history of *Rheumatobates rileyi* Berg., *Hemiptera—Gerridæ*)," *Papers of Mich. Acad. Sci., Arts and Letters*, 1930, **13**, 433–46, 1 pl.). The title is self-explanatory of the subject-matter of this paper. Notes are given on the collecting apparatus used in this study, the habitat and distribution of the insect, laboratory culture, its general food habits, its predatory habits, its nocturnal life, mode of breeding, oviposition, the general habits of the insect, its life-history, and the various stages of development. M. E. M.

Oribatid Mites.—A. P. Jacot ("Oribatid Mites of the subfamily *Phthiracarinæ* of the North-Eastern United States," *Proc. Boston Soc. Nat. Hist.*, 1930, **39**, no. 6, 209–61, 10 pls., 1 text-fig.). The unusual degree of misunderstanding in this family is considered by the author to be due to three factors :—(1) Incomplete study of existing literature; (2) superficial study of original descriptions; (3) disregard of genotypes. In order to ensure common understanding, the history of the family is first presented by the author in detail under four heads :—(*a*) the generic names; (*b*) the genotypes; (*c*) phylogenic arrangement; (*d*) identification and re-identification—the reason for the errors being pointed out. This is followed by a description of the terminology of the external morphology and a detailed description of the species and their distribution. In the case of each species an attempt has been made to correlate the United States species with those of Europe, but, owing to the very meagre descriptions and inadequate figures, this has often been found impossible. M. E. M.

Evolution of the Class Insecta.—J. Tillyard ("The Evolution of the Class Insecta," *Proc. Roy. Soc., Tasmania*, 1930, 1–89, 19 text-figs.). The subject of this paper is, according to the author, one which is admittedly full of difficulties,

yet, at the same time, one of the greatest interest, viz., the evolution of the insects as a class from some ancestral type which was not an insect, but something more primitive in its general structure. In attempting this task, the author first classifies and passes in review the various theories that have been advanced by famous zoologists or entomologists to account for the origin of this class, admittedly the highest development within the Phylum *Arthropoda*. Each main hypothesis is examined upon its merits and tested as to its validity. Having carried out this task, the author then proposes to state the position as it appears to him, and offers a new theory which attempts to embrace all the known facts of the case.

M. E. M.

Nemathelminthes.

Nematoda.

Developments in Control of Intestinal Roundworm.—JAMES E. ACKERT ("Recent Developments in the Importance and Control of the Intestinal Roundworm, *Ascaridea lineata* Schneider, of Chickens," *Proc. World's Poultry Congress*, 1930, 494–500, 4 figs.). Conditions for the development of *Ascaridea lineata* in the Central United States and in Canada were very favourable. Of 1,000 chickens examined by the author throughout the year, 40 p.c. were infested with this parasite. Detrimental effects of infestation on chickens, especially on those of two months of age or less, as shown by feeding experiments, included loss of blood and lymph, partial inanition, retarded muscular and bone development, reduction in amount of blood sugar and in size of the thymus gland, and increased mortality. A considerable resistance to infestation with *Ascaridea lineata* was acquired if chickens raised on diets adequate for normal growth and development were kept free of parasites until they were 10 or 12 weeks old. Other control methods included the placing of young chicks on "clean" ground by rotation of yards and other means, and by employing a special technique for isolating worm eggs from soil, and by treatment of adult and growing chickens with carbon tetrachloride and other anthelmintics.

J. L.

Platyhelminthes.

Trematoda.

Trematode Parasites of Philippine Vertebrates. — MARCOS A. TUBANGUI ("III. Flukes from Fish and Reptiles," *Phil. Journ. Sci.*, 1931, **44**, 417–24, 1 pl.). A description of two new genera and species, *Orientocreadium batrachoides*, gen. n. et sp. n., from the freshwater fish *Clarias batrachus*, and *Euparadistomum varani*, gen. n. et sp. n., from a young chicken-eating lizard, *Varanus salvator*. *Mesocœlium meggitti*, from the common ground lizard *Mabuia multifasciata*, is also described.

J. L.

Trematode Parasites of Philippine Vertebrates. — By MARCOS A. TUBANGUI ("IV. Ectoparasitic Flukes from Marine Fishes," *Phil. Journ. Sci.*, 1931, 45, 109–17, 3 pls.). An investigation of the cause of a heavy mortality among the marine fishes in the aquarium of the Bureau of Science in Manila resulted in the finding, in the gills of the fish, of three new species of monogenetic flukes representing three genera. One of them—a minute form—*Ancyrocephalus manilensis* sp. n., which was present in great numbers, appeared to be the pathogenic species. The infested gills showed much congestion and punctiform hæmorrhages, produced, probably, by the hooks of this parasite. All three forms are described and figured.

J. L.

Studies on the Trematode Family Strigeidæ (Holostomidæ).—JOHN P. VAN HAITSMA ("XXII. *Cotyluens flabelliformis* Faust and its Life-history," *Papers Mich. Acad. Sci., Arts and Letters*, 1930, **13**, 447–82, 2 pls.). After describing the adult of *Cotyluens flabelliformis* Faust, the author details the life-history of the parasite. This is the first of the Strigeidæ life-cycles to be determined in North America. The developmental stages were all secured from the same kind of snails, from the same lake, and during the same summer. The host pathology and the possibility of a transit development are discussed. J. L.

Studies on the Trematode Family Strigeidæ (Holostomidæ).—JOHN P. VAN HAITSMA ("XXIII. *Diplostomum flexicandum* (Cort and Brooks) and Stages of its Life-History," *Papers Mich. Acad. Sci., Arts and Letters*, 1930, **13**, 483–516, 3 pls.). The morphology of the adult is dealt with in Pt. I of this paper, Part II dealing fully with the life-history, concluding with a discussion of the economic importance of the cercarea. The conclusion is drawn that cercarea of *Diplostomum flexicandum* are responsible for the destruction of large numbers of fish in nature and in breeding ponds. J. L.

Cestoda.

Causes Underlying Increased Incidence of Broad Tapeworm in Man in North America.—TEUNIS VERGEER (*Journ. Amer. Med. Assoc.*, 1930, **95**, 1579–81). In Northern Minnesota and Canada dogs were found to be heavily infested with *Diphyllobothrium latum*, and were the chief source of infection of fish with the larvæ which might develop in man. Four out of ten samples of fæces of wild bears contained typical eggs of *D. latum*. Dogs and wild carnivora might further distribute the parasite in uninhabited as well as in heavily settled regions in North America. J. L.

An Amphilinid Cestode from an Australian Tortoise.—T. HARVEY JOHNSTON (*Austral. Journ. Exper. Biol. & Med. Sci.*, 1931, **8**, 1–7, 9 text-figs.). A preliminary account of *Austramphilina elongata* gen. n. et sp. n., specimens of which were obtained from the cœlome of the freshwater tortoise *Chelodina longicollis* from New South Wales. A new family, *Austramphilinidœ*, is proposed for the reception of this parasite, which is of unusual interest in being the first recorded Amphilinid in the southern hemisphere and the only known Amphilinid in a reptile. J. L.

Turbellaria.

Studies on the Morphology, Taxonomy and Distribution of North American Triclad Turbellaria.—LIBBIE H. HYMAN ("III.—On *Polycelis coronata* Girard," *Trans. Amer. Micr. Soc.*, 1931, **50**, 124–35, 2 pls.). A description of *Polycelis coronata*, specimens of which were obtained from mountain streams in South Dakota. J. L.

Rotifera.

Alternating Modes of Reproduction.—A. FRANKLIN SHULL (Michigan) ("Determination of Types of Individuals in Aphids, Rotifers and Cladocera," *Biol. Rev.*, 1929, **4**, 218–48). This is a review of sundry investigations into cycles involving alternating modes of reproduction, as such have become known in the three groups—Rotifers, Aphids and Cladocera—which have been selected for discussion for the reason that their cycles are fundamentally alike. After briefly stating for each group the usual course of the cycle in such species as are known to

possess it, the author proceeds to refer to the behaviour of the various forms, which have been experimented upon, in the presence of varying conditions, both physical and alimentary, as recorded by laboratory workers in recent years. The several factors which mainly influence the varying conditions of life are separately discussed in relation to each group, and the results obtained by each worker considered in their bearing upon each factor, as these are successively dealt with. Starting with temperature and nutrition, as obviously ever-changing features of the environment (the latter including quite a variety of subsections, such as the influence of oxygen, of green food, of various chemicals, etc.), the influence of light, the physiological mechanism of response, internal factors, the existence of an inherent cycle and sex determination, are among the principal of the topics handled. To prevent misconception, it should be said, as regards Rotifera, that the species actually known to possess such a cycle as that discussed in this article are extremely few in number. Even if all those forms in which the males are known were ultimately proved to enjoy the advantage which such a cycle would indicate, they would still amount to but a moderate percentage of the known species. D. L. B.

Protozoa.

Observations on a Cricket-Gregarine.—L. M. Smith ("Further Observations on the Protozoan *Tettigonospora* (new name for *Coccospora* Smith, 1929)," *Calif. Pub. Zool.*, 1930, **33**, 445–7). The name *Tettigonospora* is proposed to replace *Coccospora stenopelmati*, a new genus and species of gregarine found in the intestines of Jerusalem crickets, *Stenopelmatus fuscus* and *S. pictus*. The name *Coccospora* is preoccupied. Experimental infection of other crickets with this gregarine was undertaken. *S. intermedius* acquired an infection, but *Ceuthophilus* sp. and *Gryllus assimilis* were refractory. C. A. H.

Ciliates from Indian Ox.—C. A. Kofoid and R. F. MacLennan ("Ciliates from *Bos indicus* Linn.," *Univ. Calif. Pub. Zool.*, 1930, **33**, 471–544, 4 pls., 17 figs.). A systematic description of the ciliates of the genus *Entodinium* found in the Indian ox, *Bos indicus*, from India and Ceylon. The morphological characters of the genus are described in detail. A systematic account, illustrated by figures, of 20 species occurring in this host is given; 15 species are new. C. A. H.

Life-history of Amœba.—P. L. Johnson ("Reproduction in *Amœba proteus*," *Arch. Protistenk.*, 1931, **73**, 463–98, 9 figs.). In view of the many conflicting views regarding the reproduction of *Amœba proteus*, the author has re-investigated the life-cycle of this organism. The amœba was cultivated in a medium composed of 100 cc. spring water +100 cc. distilled water, 0·2 gm. timothy hay stems and 1 cc. culture fluid containing *Chilomonas* and other protozoa, as food organisms. It was found that binary fission is the only method of reproduction in this amœba. Sometimes, however, the cytoplasm fails to divide and multinucleate forms are produced. These divide by plasmatomy. Some of the small amœbæ occurring in cultures, and attributed to *A. proteus*, are actually *A. dofleini*, while other forms, including flagellated ones, are developmental stages of Mycetozoa. Various cytoplasmic structures described in *A. proteus* were found to be either parasites or moulds. C. A. H.

Effect of Light upon Amœba.—S. O. Mast and H. R. Hulpieu ("Variation in the Response to Light in *Amœba proteus*, with Special Reference to the Effects of Salts and Hydrogen-ion Concentration," *Protoplasma*, 1930, **11**, 412–31). In amœbæ subjected to light of different intensity there is a great variation in

the time required to produce a response. The authors describe the results of experiments designed to ascertain some of the factors causing these variations. If the illumination is rapidly and extensively increased, amœbæ respond with cessation in protoplasmic streaming. This does not stop at the same time in all parts of the body. The reaction time is longer in the centre than in the pseudopodia. The size and age of the pseudopodia and the physiological condition of the organism are also involved in the variation in the reaction time. In water containing salts and other substances the reaction time is more variable than in pure water. Increase in *p*H causes increase in reaction time if HCl is added to the solution, but it causes decrease if CO_2 is added. The lower the viscosity of the cytoplasm the shorter the reaction time. C. A. H.

Conjugation in Paramæcium.—D. Raffel ("The Effect of Conjugation within a Clone of *Paramecium aurelia*," *Biol. Bull.*, 1930, **58**, 293–312). Experiments were conducted with the object of determining the effect of conjugation upon inherited variation within a clone of *Paramœcium aurelia.* Care was taken to exclude environmental diversities in the lines tested. The infusoria were cultivated in the following medium: KNO_3 0·5 gram, K_2HPO_4 0·06 gram, $MgSO_4$ 0·02 gram, $FeCl_3$ 0·001 gram, distilled water 1,000 grams. A unicellular green alga was used as food organism. Ex-conjugant lines were compared with non-conjugant lines from the same parent clone with respect to the rates of fission. It was found that conjugation within a clone of *P. aurelia* produces diverse biotypes, having different inherited fission rates. The differing rates of non-conjugant lines are not inherited. C. A. H.

Effect of Oxygen upon Locomotion in Amœba.—H. R. Hulpieu ("The Effect of Oxygen on *Amœba proteus*," *J. Exp. Zool.*, 1930, **56**, 321–61, 13 figs.). The author has investigated the effect of oxygen tension upon the mechanical processes involved in amœboid movement, using *Amœba proteus* for this purpose. If the amœba is subjected to an atmosphere of pure nitrogen or hydrogen, its rate of locomotion decreases rapidly, reaching zero in four to six hours; if the organisms are then restored to normal atmospheric conditions, this rate again increases, reaching its former value after a few hours. It was found that high activity was correlated with thick plasmagel, and low activity with thin plasmagel. The rate of fission is markedly decreased in amœba subjected to insufficient oxygen. Similar changes are obtained with oxygen below 0·005 or above 1 atmosphere. C. A. H.

Methods of Infection of Termites by Protozoa.—B. J. Andrew ("Method and Rate of Protozoan Refaunation in the Termite *Termopsis angusticollis* Hagen," *Univ. Calif. Pub. Zool.*, 1930, **33**, 449–70, 2 figs.). Investigations were conducted to ascertain the methods by which the termite *Termopsis angusticollis* normally becomes infected ("refaunated") with the intestinal flagellates. It was found that the fæces do not contain protozoa in active or encysted state, and infection could not be obtained by feeding on fæces. Protozoa are found in the unextruded pellet and in the first drop of intestinal fluid, hence the transfer of protozoa may normally occur during proctodeal feeding, and by ingestion of liquid droppings from fresh nest structures. Cannibalism also leads to a transfer of the flagellates. C. A. H.

Amœba from the Mouth of Monkeys.—C. A. Kofoid and H. G. Johnstone ("The Oral Amœbæ of Monkeys," *Univ. Calif. Pub. Zool.*, 1930, **33**, 379–92, 2 pls.). Description of the results of a morphological and cultural

study of the amœba found in the mouth of monkeys, *Macacus rhesus* and *M. cynomolgus*, imported into the United States. The main object was to determine whether this parasite was identical with *Endamœba gingivalis* of man. It is concluded that the amœba found in a high percentage of the monkeys is identical with the human oral amœba, from which it is indistinguishable in its morphological and cultural characters. C. A. H.

Encystation in Didinium.—C. D. Beers ("Some Effects of Encystment in the Ciliate *Didinium nasutum*," *J. Exp. Zool.*, 1930, **56**, 193–208). Experiments were undertaken to ascertain whether encystment in *Didinium nasutum* resulted in a renewal of vitality after a state of depression had been induced in a culture. A group of lines of this ciliate were cultured in water on an inadequate diet of *Paramœcium*. The infusoria showed a decreased fission rate and increased encystment rate. The cysts were revived by transfer to hay infusion. The ciliates hatched from these cysts, when subjected to the inadequate diet for the second time, showed a marked increase of vitality as measured by the fission and encystment rates. The transfer of depressed active ciliates from the poor medium to hay infusion failed to stimulate their vitality. It is concluded that encystment in *Didinium* serves to increase the vitality of the strain when the animals are depressed by inadequate cultural conditions. C. A. H.

Cultivation of Opalinid Infusoria.—M. M. Metcalf ("Culture Media for Opalinidæ," *Science*, 1930, **72**, 561–2). A culture medium for the Opalinidæ should satisfy the following three requirements: (1) Supply of predigested food; (2) Absence of free oxygen in the culture fluid; (3) Absence of contamination of the medium. So far, no adequate culture medium for these infusoria has been devised. The most difficult part of the problem, according to the author, is to keep the medium free of oxygen. C. A. H.

New Flagellates.—G. Roskin ("Neue Flagellatenarten," *Arch. Protistenk.*, 1931, **73**, 203–5, 5 figs.). Description of five new species of flagellates from fresh-water pools near Moscow: *Acinetactis polymorpha* sp. n., *Anisonema obliquum* sp. n., *Urceolus ovatus* sp. n., *Actinomonas radiosa* sp. n., *Codonosiga ornata* sp. n.
C. A. H.

A New Ciliate Parasitic in Molluscs.—R. F. MacLennan and F. H. Connell ("The Morphology of *Eupoterion pernix* n. gen., n. sp., a Holotrichous Ciliate from the Intestine of *Acmæa persona* Eschscholtz," *Univ. Calif. Pub. Zool.*, 1931, **36**, 141–56, 1 pl., 2 text-figs.). Description of a new holotrichous ciliate parasitic in the intestine of a Californian mollusc, *Acmæa persona*. The ciliate, named *Eupoterion pernix* gen. n., sp. n., is closely related to *Cryptochilum* and *Conchophthirius*. It is small, 38–56μ long; slightly flattened laterally, has short cilia arranged in about 48 rows, 6 rows of heavy peristomial cilia; single contractile vacuole located posteriorly. Cytostome in postero-ventral edge of the body. There is a distinct neuromotor system. C. A. H.

Blood Protozoa of Japanese Frogs.—M. Tanabe ("Studies on the Blood-Inhabiting Protozoa of the Frog," *Keijo J. Med.*, 1931, **2**, 53–71, 3 pls.). An account is given of *Dactylosoma ranarum* and *Trypanosoma rotatorium*, parasitic in the Japanese frog, *Rana nigromaculata*. The morphology and development of these parasites are re-described and somewhat extended. On the whole, the previous findings are confirmed. C. A. H.

Cultivation of Amœba from Rats.—N. KUWABARA ("On the Cultivation of *Entamœba muris* (Grassi, 1879) *in vitro*," *Keijo J. Med.*, 1931, **2**, 28–30). The author has succeeded in cultivating *Endamœba muris* from a white rat in Tanabe and Chiba's medium (*cf.* this Journal, 1930, **50**, 451). The fluid part of the medium consisted of inactivated horse serum added to Ringer's solution in the proportion of 1 : 8. C. A. H.

Vitality of Amœbæ.—S. O. MAST ("Effect of Salts, Hydrogen-ion Concentration, and Pure Water on Length of Life in *Amœba proteus*," *Physiol. Zool.*, 1931, **4**, 58–71). The author has investigated the effect of various chemicals upon the length of life of *Amœba proteus* in culture. In pure water, without food, the amœbæ live normally for about 16 days. The addition of salts prolongs their life. Single salt solutions N/1,000 can be arranged in the following descending order, as regards the length of life of the amœba: sodium, magnesium, calcium, potassium, ammonium salts. The relative toxicity of different salts depends upon their concentration. The range of *p*H in which *A. proteus* can live is very wide; from 3·8 to 8·2. Beyond these the length of life decreases rapidly. C. A. H.

Great Barrier Reef Boring.—F. CHAPMAN ("A Report on Samples Obtained by Boring into Michaelmas Reef, about 22 miles N.E. of Cairns, Queensland," *Reports of Great Barrier Reef Committee* (no date on reprint), **3**, 32–42, pls. IX–X). The boring was carried down to a depth of 600 feet, but the uppermost samples, being solid coral rock, are not included in this report. From a depth of 32 feet the material was systematically examined, and is seen to vary considerably in character in successive zones, the depths of which are given. There appear to be some gaps in the series, e.g., the first sample represents cores between 32–42 feet deep; the second sample 90–93 feet, no description being given of the intervening cores. Foraminifera form an important constituent in the majority of samples, though often worn and unrecognizable. They are abundant down to about 100 feet, then rare or indeterminable to 348 feet, when they again become abundant and so continue to the bottom of the core. A list of the species identified in each section is given, the majority being species normally found at the present day on or near the Barrier Reef. A. E.

Some Foraminifera from the Indo-Pacific Region.—J. HOFKER ("Sur quelques foraminifères. Résultats scient. du voyage aux Indes orientales néerlandaises, etc.," *Brussels*, 1930, *Mem. Mus. Roy. d'Hist. Nat. de Belgique Hors séries* **2**, fasc. 1, 1–12, pls. I–III.) Only 11 species, mostly large and common, are dealt with, each at some length. The author explains that, with the exception of the single specimen of *Haddonia torresiensis* Chapman, he has already dealt with all the forms in his monograph on the *Siboga* Expedition, but the beauty of the specimens and their novel localities justify treatment at greater length. Considerable attention is paid to the internal structure as shown in sections. A. E.

Japanese Foraminifera.—YOSHINE HADA ("Report on the Biological Survey of Mutsu Bay. 19. Notes on the Recent Foraminifera from Mutsu Bay." *Science Reports*, *Tohoku Imperial Univ.*, *4th ser.* (*Biology*), 1931, **6**, no. 1, 45–148, 95 text-figs.). The material dealt with was collected by dredge and tow-net during August 1927, and June 1928, at about 30 stations in Mutsu Bay. None of the stations exceeded 33 fathoms in depth, and the material yielded 94 species and 6 varieties, 11 of the species being new to science. No information is given as to the nature of the material examined or the bottom temperatures, but the presence of no less than 26 species with arenaceous tests indicates a cold-water fauna. Curiously enough, in these circumstances two new species of the genus *Nouria*,

which is generally a warm-water type, are described, in addition to the widely distributed species *N. polymorphinoides* H.-A. and E. The text-figures are good and sufficient for purposes of identification, and the report, which is in perfect English, is a valuable addition to our knowledge of the foraminiferal fauna of a little-known region. A. E.

Pliocene and Pleistocene Foraminifera.—W. STORRS COLE ("The Pliocene and Pleistocene Foraminifera of Florida," *Florida State Geol. Survey*, Bull. 6, 1931, 1–80, 7 pls.). The Pliocene and Pleistocene formations of Florida contain characteristic faunal groups of foraminifera, by means of which the individual formations may be recognized. They also supply valuable information as to the conditions of deposition. The Caloosahatchee marl (Pliocene) contains the most varied and abundant fauna, and many of the species are still living in the West Indian region. It was clearly deposited in shallow warm water. The Charlton formation furnishes only one species, *Rotalia beccarii* var. *tepida* Cushman, and on such evidence it is impossible to state the age of the deposit, which is doubtfully assigned to the Pliocene. From what is known of the life-history of var. *tepida*, it may be assumed that the deposit was laid down under very brackish water conditions. Of the two Pleistocene formations, the Fort Thompson has a fauna limited in species but closely related to the underlying Caloosahatchee marl, while the Anastatia formation has a much more varied and prolific fauna indicating deposition in shallow and relatively cool water. The difference between the Pliocene and Pleistocene faunas is regarded by the author as connected with the climatic disturbances which accompanied the Continental ice sheet, but for which the Pleistocene fauna would resemble the Pliocene and the recent West Indian faunas. He considers it evident that the more tropical elements of the Pliocene fauna were driven south during Pleistocene times, while the more adaptable remained to form the Pleistocene deposits. The difference between the Pliocene and Pleistocene faunas is one of adaptability to temperature rather than of extinction and replacement. There is a tabular statement showing the range and abundance of the 93 species and varieties recorded, four of the species and one variety being new to science. The illustrations are good. A. E.

"Challenger" Localities.—W. L. F. NUTTALL ("Additional Localities of the 'Challenger' Foraminifera," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 106, 46–7). A short note supplementing the information published by the author in 1927 on the "Localities whence the Foraminifera figured in the Report of H.M.S. 'Challenger' by Brady were derived" (*Ann. Mag. Nat. Hist.* (London), 1927, ser. 9, **19**, 209–41). It will increase the value of the original paper. A. E.

West Indian Chalk.—J. A. CUSHMAN ("Cretaceous Foraminifera from Antigua, B.W.I.," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 105, 33–46, pls. V–VI). A very white, fine-grained and friable chalk from a well in Antigua, at a depth of 40 feet, yielded 21 species of foraminifera. The number, though small, is sufficient to show the affinity of the deposit to the "Craie Blanche" of the Paris Basin, as nearly all the species found have been described by d'Orbigny in his memoir on that deposit, or by other authors from similar formations in Central Europe. This fact, and the occurrence of most of the species in the Taylor marl of Texas confirm the fact that the American Upper Cretaceous is for the most part identical with that of Europe, and most of the species are common to the two regions. The Antiguan chalk is apparently somewhat lower in the section than the recently discovered Cretaceous of Trinidad, W.I. All the species observed are adequately figured. There are no novelties. A. E.

A New Virgulina.—J. A. CUSHMAN and G. M. PONTON ("A New *Virgulina* from the Miocene of Florida," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 104, 32–3, figs. on pl. IV). The new species *Virgulina miocenica* is closely related to *V. gunteri*, Cushman, from Florida Miocene, and also to *V. pertusa*, Reuss, from the Miocene and Pliocene of Western Europe. All three species are marked by depressions on the sutural lines. The new species is stated to be abundant in the Shoal River, but rare in the Oak Grove marls. A. E.

Late Tertiary Foraminifera from Fiji.—J. A. CUSHMAN ("New Late Tertiary Foraminifera from Vitilevu, Fiji," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 103, 25–32, figs. on pl. IV). Twelve new species are described and figured from fossil *Globigerina* ooze collected on the Island of Vitilevu, which is very rich in foraminifera. The fauna is typical and widely distributed in the late Tertiary of the Indo-Pacific area, and most of the species are still living in that area. The majority of the species have already been recorded by Brady, Schwager, Schubert and others, from similar deposits. A complete paper on the deposit is in preparation. The new species are well figured. A. E.

Some New Species.—F. CHAPMAN and IRENE CRESPIN ("Rare Foraminifera from Deep Borings in the Victorian Tertiaries, pt. 2," *Proc. Roy. Soc., Victoria*, 1930, **43** (1), 96–100, pl. V). Six new species and one new variety are described and figured, all obtained from deep borings in the East Gippsland area. It is stated that most of them are of value as zone markers, especially in the older part of the Tertiary series. They include two species each of *Cyclammina* and *Carpenteria*, a species of *Vaginulina* and one of *Lamarckina*, and a variety of *Lingulina*.

A. E.

Two New Genera.—F. CHAPMAN and W. J. PARR ("Notes on New and Aberrant Types of Foraminifera," *Proc. Roy. Soc., Victoria*, 1931, **43** (2), 236–40, pl. IX, 1 text-fig.). The new genus *Heronallenia*, named after a former president of this society, is created for some abnormal species hitherto assigned to *Discorbina* and *Discorbis*, the genotype being *Discorbina wilsoni* Heron-Allen and Earland 1922, from "Terra Nova" material in the Antarctic. The main point of distinction is based on the aperture, which, in *Heronallenia*, is described as "a strongly-arched slit situated in a depression on the inner face of the last chamber — usually a radially striate ornament converging upon the aperture." The following species are assigned to *Heronallenia* by the authors: *Discorbina lingulata* Burrows & Holland, 1895; *Discorbis pulvinulinoides* Cushman, 1915; *Discorbina lingulata* var. *unguiculata* Sidebottom, 1918; *Discorbina wilsoni* H.-A. & E. 1922, and *Discorbis kempii* H.-A. & E. 1929. The new genus *Hofkerina* belongs to the family Victoriellidæ, which includes free-growing individuals related to the adherent genus *Carpenteria*. The test is trochoid, biconvex, with few inflated chambers; the wall thick, laminated and rather coarsely tubulate; papillate above, smooth beneath and with a cribrate aperture in the umbilical depression. The genotype is named as *Pulvinulina semiornata* Howchin 1889 from the Oligocene (Balcombian) of Muddy Creek, Victoria. The authors suggest that *Pegidia* Heron-Allen & Earland 1928 (J.R.M.S. 1928, **48**, 283–99) may prove to be related to the genera comprised in the family Victoriellidæ, and consider that the *Pulvinulina decipiens* of H.-A. & E. 1928, *ibid.*, is very similar to the genotype of *Hofkerina*. In the same paper is a note "On an Anomalous Specimen of *Homotrema rubrum* (Lamarck)," found on coral fragments from Ambrym Island, New Hebrides. The specimen presents a transitional structure at first sight, simulating *Polytrema* but retaining in most respects the typical *Homotrema* character of perforate areolæ.

A. E.

BOTANY.

(*Under the direction of* A. B. Rendle, D.Sc., F.R.S.)

GENERAL.

Cytology.

Incompatibility in Polyploids.—W. J. C. Lawrence ("Incompatibility in Polyploids," *Genetica*, 1930, **12**, 269–96). The theory of incompatibility in polyploids is discussed in detail, with special reference to the behaviour of incompatibility in polyploids and the segregation of genetic types in polyploids of different constitution. Cytological evidence is adduced for the tetraploid nature of *Verbascum phœniceum*. A new interpretation of Sirk's work on this species is shown to give a better approximation to observation when the incompatibility of *Verbascum* is considered on an allotetraploid basis. *Cardamine pratensis* is a polyploid ($2n$ = ca. 30). The work of Correns on this species is discussed on the same basis as for *Verbascum*, and again a polyploid interpretation is found to be more satisfactory. A list is given of the chromosome numbers of some plants exhibiting incompatibility, and the behaviour of certain of these is briefly discussed. The polyploid theory is shown to imply that like factors in pollen and style positively inhibit, and unlike factors positively promote, pollen tube growth, but the potencies of these two opposite reactions are unequal. J. L.

Sexual Incompatibility of Raphanobrassica.—G. D. Karpechenko and S. A. Shchavinskaia ("On Sexual Incompatibility of Tetraploid Hybrids," *Proc. U.S.S.R. Congress Genetics, Plant and Animal Breedings*, 1929, **2**, 267–76, Russian with English summary). *Raphanobrassica* is the fertile tetraploid hybrid of the cross *Raphanus sativus* L. with *Brassica oleracea*. The hybrids do not cross naturally with their parents. A small number of hybrids have been obtained by artificial pollination of *Raphanobrassica* with pollen of *R. sativus* or *B. oleracea*, and also by pollination of *R. sativus* with pollen of *Raphanobrassica*. The *Raphanobrassica* × *Raphanus* hybrids show low fertility and the single *Raphanobrassica* × *Brassica* hybrid was completely sterile. This sexual incompatibility of *Raphanobrassica* with regard to its parents is connected with the double chromosome complex, as the diploid F_1 hybrids of *Raphanus* × *Brassica* are readily crossed with the *Raphanus* parent. The functioning gametes in the diploid hybrids were the same as are formed in *Raphanobrassica*, therefore the somatic tissues influence the ability to cross. According to its morphological characters, fertility and constancy, the authors consider *Raphanobrassica* a new genus. The establishment of its sexual incompatibility seems a proof of the fact that new species or genera may originate through duplication of the chromosome complex in hybrids from distant crosses. The authors point out the risk of judging the phylogenetic relationships of species with different chromosome numbers, on the basis of the degree of ability to cross or sterility of their hybrids. J. L.

Raphanus-Brassica Hybrids.—G. D. KARPECHENKO ("A Contribution to the Synthesis of a Constant Hybrid of Three Species," *Proc. U.S.S.R. Congress Genetics, Plant and Animal Breedings*, 1929, 2, 277–94, Russian with English summary). The cross *Raphanus sativus* L. with *Brassica oleracea* L. produces the fertile and constant tetraploid hybrid *Raphanobrassica* $n = 18$. F_1 hybrids of *Raphanobrassica* have been obtained with *B. carinata*, *B. Napus*, *R. Raphanistrum*, *B. pekinensis* and *B. campestris*. *Raphanobrassica* crosses most readily with *B. carinata*, while its parents do not cross either with *B. carinata* or with *Raphanobrassica* itself. All the hybrids were normal, vigorous plants, showing characters intermediate between those of the parents. Seeds were produced from those which flowered in the first year. All the hybrids are seen cytologically to be true triheterogenomous plants. Their somatic chromosome numbers are tabulated together with the haploid numbers of the parents. In the hybrids *R.* × *B. carinata* 9 to 17 bivalents and 17 to 1 univalents are present at first metaphase ; in *R.* × *B. campestris*, 5 to 6 bivalents and 18 to 16 univalents ; in *R.* × *R. Raphanistrum* 9 bivalents and 9 univalents. Meiotic irregularities occur at both divisions, and may lead to the formation of gametes with the somatic chromosome complement. J. L.

Quamoclit Hybrids.—F. KAGAWA and G. NAKAJIMA ("Genetical and Cytological Studies on Species Hybrids in *Quamoclit*," *Proc. Crop Sci. Soc., Japan*, 1930, 2, Japanese with English summary). The F_1 plants of *Quamoclit angulata* × *Q. pennata* were intermediate between the parents regarding leaf and flower shape. The F_1 plants somewhat resembled *Q. Sloteri*, a known hybrid of *Q. coccinea* × *Q. pennata*. Many individuals of the F_1 were completely sterile. The somatic chromosome numbers were determined as follows : *Q. angulata* 28, *Q. pennata* 30, the F_1 hybrid 29. Thirteen p.c. of the F_1 pollen mother-cells formed dyads, which, owing to meiotic irregularities, might possess an irregular or the somatic number of chromosomes. The F_1 plants of *Q. coccinea* var. *hederifolia* × *Q. pennata* were also intermediate between the parents regarding leaf and flower shape, and showed less resemblance to *Sloteri* than the other hybrid studied. Some individuals were completely sterile. The somatic chromosome number in *coccinea* var. *hederifolia* was 28, and 29 in the F_1 hybrid with *pennata* ; 4·7 p.c. of the pollen mother-cells formed dyads, with an irregular or the somatic number of chromosomes. The authors point out that if analogous meiotic irregularities occur in the female gametogenesis, the possibility arises of the formation of new fixed species with $2n = 58$. J. L.

A Sesquidiploid Tabacum-Sylvestris Hybrid.—J. M. WEBBER ("Interspecific Hybridization in *Nicotiana*. XI. The Cytology of a Sesquidiploid Hybrid between *Tabacum* and *Sylvestris*," *Univ. Calif. Pub. Botany*, 1930, **11**, 319–54). The term sesquidiploid is proposed for a hybrid whose chromosome garniture is diploid for one parent and haploid for the other. The hybrid occurred in 1926 and was maintained several years by vegetative propagation. Cytological and genetical evidence indicates that the plant was produced from the fertilization of a diploid *tabacum* (*t*) egg by a haploid *sylvestris* (*s*) pollen grain. The plant was highly fertile and possessed 60 somatic chromosomes. At first metaphase there were usually 24 bivalent *tabacum* chromosomes and 12 univalent *sylvestris* chromosomes. Rarely from 1 to 4 trivalents (*tts*) were observed. Gametes of the sesquidiploid hybrid received 24 *tabacum* chromosomes and from 3 to 7 *sylvestris* chromosomes. The F_1 of the plants sesquidiploid × *tabacum* had 24 bivalents + 1 to 9 univalents. The F_1 of the plants sesquidiploid × *sylvestris* had 12 univalents + x trivalents + $(12-x)$ bivalents where x ranged from 1 to 7. Somatic gametes were formed in this progeny. The F_2 sesquidiploid hybrid plants have from 24 to 29 bivalents and from 1 to 8 univalents. Later generations of selfed

progenies of the sesquidiploid hybrid showed variation in external morphology. Evidence is given that this is due to duplication of homologous *tabacum* chromosomes and replacement of *tabacum* by *sylvestris* chromosomes. It is considered that the new forms would not survive under natural conditions unless isolated from *N. tabacum*. J. L.

Haploid Crepis Plants.—L. HOLLINGSHEAD ("A Cytological Study of Haploid *Crepis* Plants," *Univ. Calif. Pub. Agric. Sci.*, 1930, **6**, 107–134). Five haploid *Crepis capillaris* plants were found in over three thousand F_1 hybrids of *C. capillaris* × *tectorum*. A sixth haploid resulted from the cross *C. capillaris* × *setosa*. The haploids were due to the parthenogenetic development of *capillaris* egg cells. In morphology they resembled reduced diploids, but showed marked differences in leaf shape and habit of growth. The haploid chromosome complex of three individually different chromosomes was usually seen in root tips. Parts of root tips in each haploid were diploid, and some tips wholly diploid. Diploid areas and branches also occurred in the aerial portions of the plants. The haploid portions of the plants were sterile, but achenes were obtained from diploid parts of one plant, and the progeny were uniform in appearance. The meiotic divisions in the pollen mother-cells of the haploids showed many irregularities, e.g., the occasional division of univalents at diaphase, the frequent division of univalents, but the inclusion of most pairs of daughter halves in the same nucleus, the omission of the homeotypic division. As a result, very few normal microspores were formed, and very little good pollen was produced. In diploid tissue three bivalents were formed in many pollen mother-cells, but non-conjunction of one or more pairs was frequent. This lack of pairing between presumably completely homologous chromosomes shows that complete homology does not necessarily result in bivalent formation at meiosis. J. L.

Inheritance in Nicotiana.—R. E. CLAUSEN ("Inheritance in *Nicotiana tabacum*. X. Carmine-Coral Variegation," *Cytologia*, 1930, **1**, 358–68). The univalent chromosome of "fluted," a primary monosomic of *Nicotiana tabacum*, may be designated as the F-chromosome. Then normal carmine $= 23_{II} + F_{II}$, and fluted carmine $= 23_{II} + F_{I}$. The recessive type, coral, a derivative of fluted, is shown to have arisen by a modification of the F-chromosome, which may be represented by F-co. Hence, normal coral $= 23_{II} + \text{F-co}_{II}$, and fluted coral $= 23_{II} + \text{F-co}_{II}$. The *de novo* origin of a carmine-coral variegated type from fluted ♀ × coral ♂ is described, and it is shown to depend upon the presence of a fragment of the F-chromosome, *f*-Co, containing the factor or factor complex for carmine as opposed to coral. Hence, normal carmine-coral $= 23_{II} + \text{F-co}_{II} + f\text{-Co}_{I}$, and fluted carmine-coral $23_{II} + \text{F-co}_{I} + f\text{-Co}_{I}$. J. L.

Meiosis in Progenies of X-rayed Nicotianas.—T. H. GOODSPEED ("Meiotic Phenomena Characteristic of First Generation Progenies from X-rayed Tissues of *Nicotiana tabacum*," *Univ. Calif. Pub. Bot.*, 1930, **11**, 309–18). Irradiation during the period of greatest nuclear activity in *Nicotiana tabacum* is followed by extensive chromosome alterations which may cause non-viability of the gametes. Less severe alterations, however, give a considerable number of viable gametes. Meiosis has been studied in X_1 individuals of X-rayed *tabacum* plants and found to exhibit the following types of alteration in the typical chromosome complement: chromosome fragmentation, chromosome "additions" or "fusions," non-conjunction and unpaired chromosomes. Monosomics $(23_{II} + 1_{I})$ and trisomics $(24_{II} + 1_{I})$ are the most frequent classes found in the X_1 progeny when failure to conjugate is induced at gametogenesis. J. L.

Chromosome Numbers.—L. O. Gaiser ("Chromosome Numbers in Angiosperms, III," *Genetica*, 1930, **12**, 162–260). A list of chromosome numbers, including the results of researches published in 1929, and some of 1928, which were not included in the author's earlier lists. The arrangement of species under families and orders is according to Engler and Gilg. The species and varieties are listed in alphabetical order. J. L.

New Chromosome Number in Brassica.—T. Morinaga and E. Fukushima ("Another New Chromosome Number in *Brassica*," *Bot. Mag., Tokyo*, 1930, **44**, 373–4). In both *Brassica Napus* and *B. Napus* var. *oleifera* there are 19 haploid chromosomes. A new number has been found in *B. carinata*, where $n = 17$. J. L.

Chromosome Numbers in Potatoes.—A. E. Longley and C. F. Clark ("Chromosome Behaviour and Pollen Production in the Potato," *Journ. Agric. Research, Washington*, 1930, **41**, 867–88). The haploid chromosome number 12, 18, 24 or 36 was found in ten wild species of potato. *Solanum Commersonii* and *S. cardiophyllum* f. *coyoacanum* ($n = 18$) show meiotic irregularities at microsporogenesis similar to irregularities in known hybrids. Three cultivated varieties of *S. tuberosum* from South America have $n = 12$, while 37 cultivated varieties from U.S.A. have $n = 24$. In the 24-chromosome varieties meiosis is rarely regular; often extremely irregular. Pollen is produced only from the few varieties showing no meiotic abnormalities. In some individuals environmental changes appeared to affect chromosome behaviour. From the cytological observations it is suggested that cultivated potato varieties have a mixed ancestry in two or more wild species. J. L.

Chromosomes in Caprifoliaceæ.—Karl Sax and D. A. Kribs ("Chromosomes and Phylogeny in Caprifoliaceæ," *Journ. Arnold Arboretum*, 1930, **11**, 147–53). Haploid chromosome numbers in Caprifoliaceæ have been determined as follows: *Sambucus* 18, *Viburnum* 9, *Symphoricarpus* 9, *Abelia* 16, *Kolkwitzia* 16, *Diervilla* 9, and *Lonicera* 9, 18 and 27. The chromosomes of different genera show great size variation. There is no correlation between either chromosome number or chromosome size and the amount of vascular specialization of the genera in this family. It appears that differentiation of genera has been associated with changes in chromosome size, and that changes in chromosome number are probably of minor significance. J. L.

Chromosomes in Quercus.—H. J. Sax ("Chromosome Numbers in *Quercus*," *Journ. Arnold Arboretum*, 1930, **11**, 220–3). The species and hybrids of *Quercus* studied are of the subgenera *Erythrobalanus* and *Lepidobalanus*. In all cases the haploid chromosome number was 12 or 12 ± 1. Pollen-grain size and pollen-grain fertility also show remarkable uniformity among both pure species and hybrids, the hybrids showing no significant difference in sterility from that found in pure species. A table is given showing the place of origin, the number of chromosomes, the average size of pollen grains and the percentage of sterility of each species investigated. J. L.

Chromosome Numbers of Cultivated Plants.—T. Morinaga, E. Fukushima, T. Kano, Y. Maruyama and Y. Yamasaki ("Chromosome Numbers of Cultivated Plants," *Bot. Mag., Tokyo*, 1929, **43**, 589–94). The following chromosome numbers are recorded: *Andropogon Sorghum* var. *vulgaris* $2n = 20$, *Setaria italica* $2n = 18$, *Yucca filamentosa* $n = 30$, *Musa basjo* $n = 11$, *Zingiber mioga*

$2n = 55$? $n = 28$? *Celosia cristata* $n = 18$, *Phytolacca acinosa* var. *Kœmpferi* $n = 18$, *Nelumbo nucifera* $2n = 16$, *Illicium anisatum* $n = 14$, *Nandina domestica* $n = 10$, *Eschscholtzia californica* $n = 6$, *Hydrangea opuloides* $n = 18$, *Chænomales Lagenaria* $n = 17$, *Eriobotrya japonica* $n = 17$, *Mercurialis leiocarpa* $n = 24$, *Zizyphus vulgaris* var. *inermis* $n = 12$, *Thea sinensis* $n = 15$, *Punica Granatum* $n = 8$, *Rhododendron quinquefolium* var. *speciosum* $n = 13$, *Salvia nipponica* var. *argutidens* $n = 8$, *Lycium chinense* $n = 12$, *Sesamum indicum* $2n = 26$, *Luffa ægyptiaca* $n = 13$, *Centaurea Cyanus* $n = 12$, *Gaillardia pulchella* $n = 18$. J. L.

Chromosomes of Lilium tigrinum.—Y. Takenaka and T. Nagamatsu (" On the Chromosomes of *Lilium tigrinum* Ker-Gawl," *Bot. Mag., Tokyo*, 1930, **44**, 386–91, Japanese with English summary). *Lilium tigrinum*, a highly sterile plant, is found to be a triploid species. In root-tip cells there are 36 chromosomes, six being markedly larger than the rest. Of these six chromosomes three show median and three submedian attachment to the spindle. All the 30 smaller chromosomes show either terminal or subterminal attachment. At heterotypic metaphase various numbers of trivalents are observed. The sterility of *L. tigrinum* is ascribed to irregularities in meiosis, resulting in the formation of non-viable pollen grains with abnormal chromosome complements. J. L.

The Nucleolus in Oryza.—A. G. Selim (" A Cytological Study of *Oryza sativa* L.," *Cytologia*, 1930, **2**, 1–26). Twelve is found to be the haploid chromosome number in five races of rice plant examined. A single nucleolus is present in the resting nucleus of the pollen mother-cells. In two of the races the nucleolus remains single in prophase. In the other three races a second nucleolus appears, and is firmly attached to the primary nucleolus. The reticulate character of the threads is retained after the loosening of the synizetic knot, and the single or double nucleolus is attached to the thread at more than one point. The secondary nucleolus disappears during the development of the chromosomes, and probably contributes material to their formation. The primary nucleolus remains spherical till its disappearance at late diakinesis, and may contribute to spindle formation. The characteristic differences in nucleolar content of the pollen mother-cells of these five varieties of rice are correlated with the absolute and relative size of the nucleoli, and also with the time when the secondary nucleolus is budded off from the primary. J. L.

Anatomy.

Factors Affecting the Production of Summerwood in Pinus palustris.—B. H. Paul and R. O. Marts (" Controlling the Proportion of Summerwood in Longleaf Pine," *Journ. For.*, 1931, **29**, 784–96, 10 figs.). The influence of artificial irrigation and fertilization upon diameter growth and on the proportion of springwood and summerwood in *Pinus palustris*, growing in nearly sterile sand in Florida, was studied by the authors over a period of three years. The treatment applied to nine selected plots included a complete fertilizer and a nitrate fertilizer, with and without irrigation, and irrigation only during different seasons of the year. A check plot, which received no artificial treatment, was available for comparison. It is concluded that a fairly close correlation exists between the current soil water-supply and the formation of summerwood in the area concerned. The application of a complete fertilizer, with no water other than the natural precipitation appeared to increase the diameter growth of the trees to a slight degree, although more in the springwood portion of the annual ring than in the summerwood portion. A nitrate fertilizer, without irrigation, also increased the total growth, but increased

the summerwood to the greater degree. In both cases it is likely that the abundant supply of available soil moisture in 1928 and 1929 had as great an effect upon the growth of the trees as had the fertilizers. B. J. R.

Wood Structure of a Hybrid Larch.—K. A. CHOWDHURY ("Anatomical Studies of the Wood of a Hybrid Larch," *Journ. For.*, 1931, **29**, 797–805, 2 figs.). The wood structure of the Dunkeld hybrid larch, *Larix eurolepis* Henry, and of the two parents, *L. europæa* DC. and *L. leptolepis* Hort., were studied. Measurements of the horizontal and longitudinal resin canals, the rays, and the length, diameter and wall thickness of the tracheids, indicate that the hybrid has a wood structure more nearly resembling that of the female parent, *L. leptolepis*. B. J. R.

Wood Structure of Gmelina arborea.—D. NORMAND ("Note sur *Gmelina arborea* Roxb., essence de repeuplement pour la forêt tropicale asiatique," *Rev. de Bot. Appl. et d'Agric. Trop.*, 1931, **115**, 168–74, 1 pl.). The wood shows no visible distinction between sapwood and heartwood. Growth rings are marked by a colour difference or a zone deficient in pores. The average diameter of the vessels is 200–250μ; these are usually single or in groups of two or three. The rays are three to four cells wide, 100–500μ high and separated by 200–400μ. The marginal cells are a little higher than those in the body of the ray. The fibres are in fairly regular radial arrangement, septate, with a tendency to storeyed arrangement, and polygonal in cross section. Vasicentric parenchyma is present. B. J. R.

Intercellular Canals in the Wood of Flindersia.—M. B. WELCH ("The Occurrence of Intercellular Canals in the Wood of some Species of *Flindersia*," *Journ. Roy. Soc., N.S.W.*, 1930, **64**, 352–62, 4 figs., 1 pl.). Woody material was examined of *Flindersia acuminata* White, *F. australis* R. Br., *F. Bennettiana* F. v. M., *F. Brayleyana* F. v. M., *F. Bourjotiana* F. v. M., *F. Ifflaiana* F. v. M., *F. lævicarpa* White and Francis, *F. maculosa* F. v. M., *F. Oxleyana* F. v. M., *F. pubescens* Bailey, *F. Schottiana* F. v. M., *F. Pimenteliana* F. v. M. Intercellular canals were observed in *F. Bennettiana*, *F. Brayleyana*, *F. Oxleyana* and *F. Pimenteliana*, though it is very probable that an examination of further material would result in their being found in some of the other species, at any rate those in which metatracheal parenchyma is strongly developed. The canals occur most commonly in *F. Brayleyana*. They are of a gummosis type and are usually found in tangential bands of metatracheal parenchyma. The development of the smaller canals may be schizogenous, while the larger ones are schizo-lysigenous, due to the disintegration of the wood parenchyma. Alternatively, canals may arise by the breaking down of vessels and may be enlarged by the disintegration of the surrounding tissue. The contents of the canals give lignin reactions, resembling wound gum, and are, in general, similar to the contents of certain of the vessels.
B. J. R.

Anomalous Stem Structure in the Menispermaceæ.—J. K. SANTOS ("Anomalous Stem Structure in *Archangelisia flava* and *Anamirta Cocculus* from the Philippines," *Phil. Journ. Sci.*, 1931, **44**, 385–408, 8 pls., 4 figs.). The younger stems of *Archangelisia flava* and *Anamirta Cocculus* are very similar externally, but differ internally, in that the wood of the former is yellow with a yellowish juice, while the wood of the latter is whitish with a colourless juice. In transverse section the stems of both species exhibit a ring of vascular bundles separated from one another by broad medullary rays. In the adult stem both species exhibit successive concentric or excentric rings of vascular bundles of secondary and extra-fascicular origin. Secretory sacs,

which originate and develop through the disappearance of the cross walls of a row of parenchyma cells, occur in the cortical region and the outer zones of the central pith of both stems. The secretory sacs of *Archangelisia flava* are smaller (length 0·45–1·2 mm.; diameter 0·03 mm.), and usually more crooked than those of *Anamirta Cocculus* (length 0·75–3·0 mm.; diameter 0·06 mm.). The stem of *Archangelisia* is of finer texture than that of *Anamirta*, the bast fibres, wood fibres, wood parenchyma and vessels being of smaller dimensions in the former. Calcium oxalate crystals occur in the cortical parenchyma, rays and pith of both species. In *Archangelisia* these are usually prismatic, clinorhombic or raphides, while those of *Anamitra* are either rhomboidal, cubical, clinorhombic or raphides. The cells of the peripheral zones of the pith of *Archangelisia* are usually loaded with calcium oxalate crystals, with very few starch grains, and have only a few secretory sacs intermingled with them, while in the corresponding zone in *Anamirta* the cells usually contain starch grains only, and secretory sacs are relatively numerous.

B. J. R.

Anomalous Thickening of Phytocrene macrophylla.—A. S. Timmermans ("Beitrage zur Kenntniss der Anatomie und des anormalen Dickenwachstums von *Phytocrene macrophylla* Bl.," *Ann. du Jard. Bot., Buitenzorg*, 1931, **41**, 65–104, 12 pls.). The stem anatomy of the twining liane *Phytocrene macrophylla* shows a differentiation of the secondary xylem and phloem into alternating wedges. These consist of strongly-developed xylem projections with weakly-developed phloem pockets and weakly-developed xylem pockets with strongly-developed phloem plates. The unequal development of wood and secondary phloem is not apparent until after the lapse of some time, during which the cambium produces a fairly regular ring. Subsequently, separate cambia arise, from which the xylem projections, phloem pockets, xylem pockets and phloem plates develop. In this way growth-rings are formed which extend round the whole or a part of the circumference of the branches. The side branches generally show only two zones. These diverge at the nodes of the main stem. One part of the first zone unites with the first zone of the main stem, but the other larger part unites with the second zone. The second zone of the side branches is usually an incomplete ring consisting of two or more arcs. These likewise diverge at the nodes of the main stem and form incomplete rings. Later, the gaps between these are filled by incomplete rings from other side branches, so that a complete annular zone is formed. How far a zone extends downwards along the internode depends on its age. Older zones extend throughout the length of the internode and meet the zones of the next internode, with which they unite. Younger zones, on the other hand, do not extend so far along the stem. These latter are the best for studying the direction of development, as the number of their elements continually decreases; they disappear completely towards the youngest part. The zone extends downwards until it joins another zone, either in the same internode or at the next node.

B. J. R.

Notes on the Vegetative Anatomy and Female Cones of Fitzroya patagonica.—B. Sahni and T. C. N. Singh ("Notes on the Vegetative Anatomy and Female Cones of *Fitzroya patagonica* Hook. fil.," *Journ. Ind. Bot. Soc.*, **10**, 1, 1–20, 1 pl., 12 figs.). An account of the anatomy of the leaf, stem, and female cone of *Fitzroya patagonica*, based on two lots of material, one of which was found wild, whilst the other was from cultivated plants. The spreading leaves of the tree, which are apparently in whorls of three, were found in reality to be arranged spirally. The structure of the leaves is of interest because the palisade tissue develops on

the abaxial side, in which respect it differs from that of any previously described species of conifers with spreading leaves. The sunken stomata lie in two parallel bands on either side of the middle line. There are several parallel rows of stomata in each band, which may be present on one or both surfaces of the leaf, The cuticle is very thick where it is associated with the stomatal bands, but less so elsewhere. The vestibules of the stomata are plugged with a black substance. The wood structure is described as being similar to that of *Juniperus*, but no material more than 1 cm. thick was available for investigation. "Growth rings well marked, resin parenchyma scattered in spring wood. Medullary rays uniseriate, 1 to 10 cells high (mostly 1 to 3). Bordered pits on radial walls of tracheids, circular, separate. Horizontal walls of medullary ray cells sparsely pitted, vertical end walls with crowded pits. Tangential pits abundant, circular, separate." Although flowers of both sexes, and even hermaphrodite ones, have been described for *Fitzroya patagonica*, the author's material consisted only of female cones. The leaves of the cones were arranged in five alternating whorls, of which only the two uppermost ones bore ovules. There were solitary ovules on each of the scales in the fourth row from below, and five on each of those in the fifth one. The ovules were erect, two or three winged, with prominent micropylar tubes which expanded funnel-wise at the top. Mature cones were 1 cm. in diameter and formed from the scales of the two uppermost whorls. The ovuliferous scale swelled up and appeared on the fused bract-scale (of which only the triangular tip was free) as a prominent hump. The nucellus was a flat-topped cylinder. Gland-like organs of uncertain homology were present at the apex of the female cones and may, in the author's opinion, represent naked nucelli. The arrangement of the vascular strands in the scales is briefly described. C. R. M.

The Development and Vascular Organization of the Foliar Organs of Carya cordiformis.—L. M. LANGDON ("The Development and Vascular Organization of the Foliar Organs of *Carya cordiformis*," *Bot. Gaz.*, **91**, 3, 273–94, 4 figs., 2 pl.). An account of the changes which take place at the apical growing-point of seedlings of *Carya cordiformis* three to eight weeks old. There are three successive horizontal initial units in the promeristem, which are arranged in the form of an inverted cone or wedge. These are concerned with the production of the dermatogen, the cortex, and the central portion of the stem respectively. Foliar organs on the main axis of the seedling 6 to 8 weeks old consist of 6 to 8 scale leaves, 5 to 6 foliage leaves and primordia. The lateral leaf primordia arise in acropetal succession. The procambial elements of the primary vascular bundles are first seen in the primordium destined to become the upper section of the leaf base. A set of vascular strands arises deep within the primordial leaf base at the same time that the primary bundles of the lamina are differentiated. These strands basipetally maintain a direct independent course, and enter the primary vascular axis on either side of the median lamina strands. "Within the primary cylinder they occupy the slightly depressed regions of the vascular axis, while the lamina strands (lateral and median) mark the position of the ridges of that axis." These vascular elements have been described as "Cauline" bundles. Cauline strands can be distinguished in the primary vascular axis only in the embryonic stages, before leaves are produced. C. R. M.

Petrified Wood from Banke, Namaqualand.—R. S. ADAMSON ("Note on Some Petrified Wood from Banke, Namaqualand," *Trans. Roy. Soc., South Africa*, **19**, 3, 255–8, 1 pl.). An account of the structure of some petrified wood, probably of Tertiary or even post-Tertiary age. The wood, different pieces of which varied

in their state of preservation, and were not more than 20 mm. in diameter, was characterized by numerous large vessels, usually well separated from one another, or sometimes in groups of three or four. The medullary rays were numerous, broad, and conspicuous. The radial diameter of the vessels ranged from 0·05 to 0·1 mm., with an average of 0·08 mm. Small pits could be seen in some of the best-preserved material, but their structure was not very clear. The vessels are stated to have been surrounded by small elongated cells with pointed ends. The medullary rays were 2 to 6 cells wide, whilst in tangential section they were uniform in size and structure, 3 to 4 cells across at the centre, and 2 to 12 or 15 cells deep. No branched specimens were found, and the cortex, where present, had lost its cellular structure. Comparisons with living material led to the conclusion that the wood was probably that of *Ficus cordata*. C. R. M.

The Structure and Biology of the Aerial Roots of Sonneratia L. —W. Troll and O. Dragendorff ("Über die Luftwurzeln von *Sonneratia* Linn. und ihre biologische Bedeutung," *Archiv. fur wiss. Bot.*, **13**, 2 & 3, 311–473, 70 figs., 1 pl.). It is impossible, here, fully to summarize this paper, in which a detailed and complete account is given of the structure and function of the root-system of *Sonneratia* Linn. f. in all its aspects. The work is divided into two main parts. The first of these is concerned with the nature and peculiarities of the habitat of *Sonneratia*, and treats, in turn, the position of *Sonneratia* in the mangrove vegetation, and the chemical nature of the mud. The second is concerned with the root-system of *Sonneratia*, and in it are described, in turn, the morphology of the root-system in relation to the habitat, the anatomy of the subterranean and aerial roots, experimental testing of the theory that the aerial roots serve primarily for respiration, and a discussion on the question whether these roots have any respiratory function or not. Finally, there is a mathematical appendix by H. Fromherz. The main argument presented by the thesis has already been noted in another paper by the same author (Troll, W., "Über die sogenannten Atemwurzeln der Mangroven," *Ber. der deut. Bot. Gesch.*, 1930, Generalversammlungsheft, 81–99, 12 figs., 3 pls.). Briefly stated, the suggestion put forward is that the form of the root-system, as a whole, has been developed in correlation with the nature of the mud in which the plants grow. The level of the ground is constantly rising owing to the deposition of colloidal matter brought down in suspension by the rivers, when the fresh and salt water become mixed in the estuaries at high tide. It thus happens that the roots of the mangroves would become more and more deeply embedded in a medium devoid of oxygen (the mud has been shown to be practically devoid of oxygen) if there were not devices by which this is prevented. A seedling *Sonneratia* plant is at first provided with a single root, which later on develops typical fibrous branches. As the level of the ground rises, a second set of roots is formed adventitiously at a point higher up on the main stem, whilst the first set falls into disuse and becomes decomposed. Still later on, horizontal branches are put out which not only themselves develop horizontal branches of a second order, but from which there arise, in addition, negatively geotropic branches which extend above the mud. On the vertical portions of the root system thus formed there arise absorbing roots immediately below soil level, as well as thicker roots which penetrate more deeply into the mud and are thought to serve as anchor roots. Should the ground rise still farther, a second root system similar to the first is developed higher up on the main stem. The horizontal and aerial roots are for the most part covered with an investment of "aerenchyma," on account of which they have hitherto been regarded as of primary importance for respiration. However, the author considers that they are chiefly of importance as organs which regulate

the depth of the absorbing roots in relation to the constantly rising mud. It is pointed out, however, that this does not exclude the possibility that they have a respiratory significance as well. In fact, it was shown by experiments carried out in the natural habitat of the plants that carbon dioxide is given off by the aerial roots, but the author points out that their complete significance as respiratory organs cannot be fully understood until more is known concerning the total metabolism of the plants. It is pointed out that certain plants characteristic of *Sphagnum* bogs and sand dunes sometimes develop a succession of roots by which they are accommodated to the rising level of the substratum in which they grow. This phenomenon, which is shown by such plants as *Ammophila arenaria*, *Drosera rotundifolia*, *Trichophorum cæspitosum*, *Eriophorum vaginatum* and *Caltha palustris*, is thought to be analogous to the manner in which the depth of the absorbing roots of *Sonneratia* sp. is regulated. C. R. M.

The Development of Cotton-Fibre and the Structure of the Boll and Seed.—T. C. N. Singh ("Notes on the Early Stages in the Development of the Cotton-Fibre and the Structure of the Boll and Seed," *Ann. Bot.*, **45**, 178, 378–80). In this brief note the author states he has found that all the cells of the epidermis of the ovules of *Gossypium hirsutum*, *G. indicum* and *G. neglectum* are concerned in the formation of cotton fibres. This conclusion is opposed to that of Balls, who considers that only those epidermal cells which protrude above the general level of the epidermis of the ovule on the first day that the flower opens are of importance in forming the fibre. Attention is also drawn to the existence of a single cup-shaped pit at the base of each chamber of the boll. Most of the fibres are attached in these pits. It has also been found in certain Indian species of *Gossypium* that there is a single layer of palisade cells only in the outer integument of the seed. The cells in the corresponding position in the inner integument are reduced to a papery layer by the developing embryo. C. R. M.

The Range of Structure and Variations in the Function of the Traps of Utricularia.—F. E. Lloyd ("The Range of Structural and Functional Variation in the Traps of *Utricularia*," **25**, N.S., 2, 260–76, 13 figs.). A summary of the conclusions reached during an extensive investigation of the structure and mode of operation of the doors of the traps of 24 species of *Utricularia*. The most exhaustive study was made with *U. gibba* L. and *U. vulgaris* L., but in all the species examined the mechanism was found to be fundamentally the same. "There is always a line of the receipt of thrust of the door-edge, release from which by initial flexure permits the water pressure without to flex the door inwardly." A veil is formed by the partial detachment of the cuticle from the pavement epithelium, which serves to retain the water-tightness of the door. The structure of the door varies in different species and may be either thin and readily capable of bending longitudinally, or it may be thick with a broad weal. The thick doors are bent transversely, as well as longitudinally, when they open. All the species examined have the power of withdrawing the water from within the traps.

C. R. M.

Morphology.

Bi-Ovulate Pistils and Fusion of the Two Ovules in Knautia arvensis.—P. Lavialle and G. Klein ("Pistils bi-ovulés et soudure des deux ovules chez *Knautia arvensis* Coult.," *Bull. Soc. Bot., France*, **77**, 9 & 10, 593–7, 3 figs.). A description of ovaries of *Knautia arvensis*, containing two ovules in place of the single anatropous, pendent ovule characteristic of the Dipsaceæ. Two types of

abnormality were observed. In one of these the two ovules were entirely independent, whereas in the other they were more or less fused together. No appreciable variations from the normal histological structure were observed in the walls of the ovaries containing two ovules. C. R. M

The Conditions which Determine the Formation of Mature Fruits in the Pecan (Carya sp. ?).—G. W. ADRIANCE ("Factors Influencing Fruit Setting in the Pecan," *Bot. Gaz.*, **91**, 2, 144–66, 6 figs.). A description of the structure of the fruit of the pecan is first given. The pistillate flowers are produced in sessile clusters of two to six. The shell is developed from two carpels, and the orthotropous ovule is surrounded by a single integument. After pollination there is a period of about four weeks before fertilization is effected, during which the pollen tube reaches the embryo-sac by way of the chalaza, having grown downwards through the stigma and wall of the ovary. The fruits are liable to fall at three stages in their development. (1) At the time of pollination, when whole clusters dry up and become detached. The reason for this is uncertain, but it may be due to overproduction. (2) The greatest fall of fruits occurs two to four weeks after pollination. This is thought to occur when the fruits are not successfully pollinated, since fruits which were covered with bags to prevent pollination behaved in the same way. (3) The third fall, which is very small in proportion, is probably due to environmental factors. It was found that the pollen of any variety was capable of pollinating the same or any other variety provided that the stigmas were receptive at the right time. Pollination is unsuccessful when the pollen reaches maturity at a different time from that at which the stigmas are receptive. The varieties Moore, Alley, and Texas were prolific, and San Saba were protandrous every season during which they were investigated; while Moneymaker, Bolton, and Success were protogynous. It is thus clearly important to ensure that protandrous varieties are planted with those that are protogynous. The extent to which the trees are protandrous and protogynous respectively is not entirely fixed, but is partially dependent on environmental factors. High temperature and moisture in the spring favour protandry, whereas low temperature and lack of moisture at this season favour protogyny. C. R. M.

Studies in the Embryology of the Umbelliferæ. — R. SOUÈGES ("Recherches sur l'embryogenie des ombellifères," *Bull. Soc. Bot., France*, **77**, 7 & 8, 494–511, 73 figs.). This is a full account of an investigation of the embryology of *Carum Carvi* L., on which subject the author previously published a brief note in 1926. The work has now been extended to include the embryology of *Pimpinella Saxifraga* L. as well. It is claimed that the embryology of the Umbelliferæ is of great interest on account of the uncertain systematic position of the family. Three stages in the embryology of the Umbelliferæ, as a whole, can be distinguished. The first stage is represented by the changes undergone by the egg while developing into a simple 6- to 8-celled form, the second by the changes from the 8-celled form to a time when the axial pro-embryo assumes a bilateral symmetry, whilst the third stage is completed when the embryo is fully differentiated in the seed. Each of these stages in turn is described in detail for the two species studied, and the paper ends with a general discussion of the results obtained. During the first stage in *Carum Carvi* the egg-cell is divided into two by a transverse wall, and by successive transverse divisions a tetrad of four superimposed cells is formed, labelled respectively *l*, *l'*, *m* and *ci*, passing from the apex downwards. Four more or less definite types of 8-celled embryo occur. However this may be, the elements derived from *l* and *l'* give rise to the embryo proper, whilst the elements derived

from *m* and *ci* go to form the suspensor, using this term in a broad sense. During the second stage the number of different types observed is very great, but immediately before the formation of the cotyledonary protuberances three well-defined regions can be seen. (1) A swollen, ovoid portion which originated from the cells *l* and *l′*. The terminal portion of this is derived from *l* and gives rise to the cotyledons, whereas the lower part, derived from *l′*, forms the hypocotyl. (2) A median region of flattened cells, derived from *m*, forms the filamentous parts of the suspensor. (3) A basal region, sometimes as greatly swollen as the terminal portion, which forms the basal portion of the suspensor. At the commencement of this third period the cells of the terminal portion of the pro-embryo become more regular. A depression is formed at the summit at the beginning of the formation of the cotyledons. The dermatogen, plerome, and periblem are differentiated at this stage, but it was found impossible to follow these processes in detail. In *Pimpinella Saxifraga* the apical and basal cells of the bicellular pro-embryo divide transversely, to give rise to a structure of four superimposed cells, *l*, *l′*, *m* and *ci*, which eventually form the same parts of the embryo as already described for *Carum Carvi*. The 8-celled embryo normally consisted of two cells side by side, derived from *l* and *l′* respectively, and of two superimposed cells derived from *m* and *ci* respectively. However, much greater variation was met with in this species than in the previous one, and no definite types could be distinguished. From the 8-celled stage onwards the variations were even more numerous, but the regions of the embryo proper and the suspensor could be recognized. The organization of the tissues, and the formation of the histogens at the radial end of the embryo, did not occur until after the cotyledonary protuberances were evident. In the discussion it is pointed out that there are some features common to the embryology of the Umbelliferæ and Solanaceæ. Affinities with the Rubiaceæ are also shown. The author considers that, on account of these common features, together with a number of similarities in the mature plants, the Umbelliferæ and Solanaceæ should be classed together in the same order, Solanales. C. R. M.

The Development of the Pollen and Viscin Strands in Rhododendron catawbiense.—C. G. Bowers ("The Development of the Pollen and Viscin Strands in *Rhododendron catawbiense*," *Bull. Torrey Bot. Club*, **57**, 5, 285–313, 3 figs., 5 pls.). The mature pollen of *Rhododendron catawbiense* Michaux is composed of groups of four microspores enclosed in a common covering. There are slight constrictions where the individual grains come in contact with one another, and the whole tetrad has the shape of a tetrahedron with rounded corners. It is about 45μ across in its broadest diameter. Each tetrad is provided with six germinal furrows at right angles to and across the boundaries between the adjoining grains of which the tetrad is composed. Each longitudinal furrow is crossed by two transverse furrows, so that there are two germinal openings from each longitudinal furrow. Usually only one or two pollen tubes arise from a tetrad, although sometimes two, three or four are produced. It is common for one pollen tube only to emerge from a single longitudinal furrow. There are hyaline fibrils of various lengths attached to the tetrads externally. By means of these the tetrads are held together in loose masses. The fibrils form a three-dimensional system, so that the pollen tetrads are arranged in a mass like a honeycomb. This emerges from the mature anthers as a single unit or several smaller ones. The fibrils are stained readily with cyanin after treatment with eau-de-javelle, indicating that suberin is present in them. The walls of the tetrads consist of four layers. (1) The intine; (2) an inner thickening layer next to the intine; (3) a dark-staining primary layer outside the inner thickening layer; and (4) an outer thickening layer around

the periphery of the tetrad. The pollen mother-cells are at first surrounded by a wall, which apparently consists of one homogeneous substance which stains with ruthenium red. At the open spireme stage there is a gelatinous zone immediately within the pollen mother-cell which is identical with the " special mother-cell wall " mentioned by Strasburger and others in describing pollen formation. The viscin strands of the mature tetrad are formed from the wall of the pollen mother-cell. This wall having become gelatinous passes through a stage in which it is perforated and alveolar and, later, reticulated, and finally fibrillar. The material of which it is composed also becomes almost horny in texture. The middle lamella of the pollen mother-cells are still connected with the tapetum when the viscin strands are being formed. In consequence, the shredding and tearing process by which the viscin strands are formed is caused by the enlargement of the anther at maturity. The " special mother-cell walls " disappear when the viscin strands are formed, and they are replaced by the outer thickening layer of the exine in the cell wall of the mature pollen tetrad. Details of meiosis in *Rhododendron catawbiense* are given. The viscin strands are regarded as " adaptive structures for insect pollination." C. R. M.

Succulence in Plants.—G. W. Chapman (" The Cause of Succulence in Plants," *New Phyt.*, **30**, 2, 119–27, 2 figs.). After reviewing some of the theories which have been put forward concerning the cause of succulence in plants, the author describes experiments in which he induced succulence in *Tradescantia fluminensis*. The first of these was carried out on plants growing in beakers of culture solution, in a greenhouse of which the temperature varied from 55 to 100° F. This experiment indicated that lack of iron or nitrogen induced succulence, as did also an excess of potassium salts, the last-named factor being of greatest importance when the calcium supply was reduced. The factors operated most effectively at 90 to 100° F. This experiment was repeated afterwards on a larger scale, with greater care to ensure that only pure chemicals were used. It was then found that nitrogen starvation caused a reduction of the length of the internodes, reduction in the area of individual leaves, and the fleshy leaves to curl upwards. Iron starvation induced a similar state of affairs more slowly. In sections of leaves which had been induced to become succulent it could be seen that the increased thickness of the leaves was due chiefly to the enlargement of the epidermal cells. The other cells also became enlarged and the cuticle was greatly thickened. There was no evidence that the pentosan content bore any relation to succulence. Nitrogen-starved plants did not become succulent unless well supplied with potassium. The author concludes that " succulence is probably due to the greater water-retaining power of the compounds of the monovalent metals with various cell constituents as compared with the retaining power of the divalent metals. A probable additional factor is that colloids containing the monovalent metals tend to be deflocculated." C. R. M.

Morphology and Mechanism of the Flower of Globba atro-sanguinea.—L. Müller (" Über den Bau und die Mechanik der Blüte von *Globba atro-sanguinea*," *Österr. Bot. Zeitschr.*, 1931, **80**, 2, 149–61, 6 figs.). The two trimerous perianth-whorls of the flower of *Globba atro-sanguinea*, as well as the parts belonging to the andrœcium, can be distinguished from each other anatomically. Hairs present in the tube and labellum of the flower form a capillary apparatus which assists in the upward movement of the nectar. The secretion of nectar by the two sessile, epigynous honey-glands must be the result of diffusion. On the single fertile stamen a joint is formed by the narrowing of the filament just below the

point of origin of the anther. This joint works in a dorsal direction, not as in other Zingiberaceæ. The style, which lies between the thecæ, moves with every movement at the joint, and is therefore very elastic. The method by which the articulation functions is explained as follows :—(*a*) As an elastic buttress against the pushing action of the pollinator (*Globba* is probably pollinated by birds) ; (*b*) as a means of enlarging the space available to the pollinator within the flower ; (*c*) as an apparatus for drawing up and pressing out the mucous from the tubular stigma —this mucous is then re-absorbed with the adherent pollen ; (*d*) in conjunction with the four horn-like expansions of the anthers as a mechanism for scattering the pollen. The tubular style possesses a cushion of hairs on the region where it is held fast between the thecæ. These may help to prevent deformation of the passage down the style, which might be caused by the movements at the joint. A. W. E.

The Morphology of the Onagraceæ.—D. A. JOHANSEN (" Studies on the Morphology of the Onagraceæ. IV. *Stenosiphon linifolium*," *Bull. Torrey Bot. Club*, 1930, **57**, 315–25, 1 pl., 25 figs.). In the genus here dealt with, the young ovary is 4-loculate, each loculus containing a single ovule ; the fruit is one-celled and one-seeded because only one ovule is ever fertilized, the three remaining ovules always perishing. The funicle of each ovule is surmounted by a dense tuft of hairs which resemble fungal hyphæ. They extend far up into the apex of the ovary, and there is definite proof that the microgametophyte does not travel down the placenta, but breaks through at the apex of the ovary and passes through these hair-like processes to the micropyle. Similar hairs in some Umbelliferæ, in *Acer*, and in *Trichosporum*, have been supposed to nourish the microgametophyte, but in *Stenosiphon* any assistance they may afford is, probably, purely mechanical. Megagametogenesis follows the scheme typical for the family, but organization is not always perfect. Embryogenesis is normal and free from irregularities. The development of the cotyledons progresses after the ovary, still green and immature, drops from the stem. The morphological evidence shows that the intermediate position assigned to *Stenosiphon* in the author's phylogenetic scheme is justified.
A. W. E.

Carpel Polymorphism.—E. R. SAUNDERS (" Illustrations of Carpel Polymorphism, VII," *New Phyt.*, 1931, **30**, 80–118, 100 figs., 24 diagrams). Examination of " parietal " placentation in numerous genera belonging to the families Sarraceniaceæ, Droseraceæ, Bixaceæ, Flacourtiaceæ, Turneraceæ, Malesherbiaceæ, Passifloraceæ, Loasaceæ, Begoniaceæ, Datiscaceæ, Rafflesiaceæ, Saxifragaceæ, Pyrolaceæ and Taccaceæ confirms the author's earlier conclusions (arrived at for the Rhœadales and Orchidaceæ) that " parietal " placentation, in the ordinary sense of the term, is not here (nor, probably, elsewhere) a reality, the ovules being borne, not on the edges of valve carpels, but on either side of the mid-line of carpels of the consolidated type described in former papers. This interpretation provides a rational explanation of many puzzling features, such as the commisural stigmas in *Bixa* and *Parnassia* ; the sub-apical origin of the styles in *Malesherbia* ; the ten-valved form of the fruit of *Blumenbachia* ; the occurrence in the Begoniaceæ of unwinged fruits in *Hillebrandia* and in a few species of *Begonia* ; the bifurcate character of the styles of *Datisca* ; the superposition on the same set of radii of the main vascular cords, the lamellæ-like placentæ, and the stigma-lobes in the gynæcium of *Cytinus* ; and the vascular anatomy in general of all the families under review. Carpel formation in *Bixa*, by the synthetic use of tissue elements originally destined for additional members, now suppressed, is suggested. The previous conclusion that obdiplostemony arises through polymorphism of the carpels is

illustrated by *Monotropa* and *Sarcocaulon*. Union for a short distance, as they turn out horizontally, of the antepetalous staminal and carpel bundles is an *incidental* and not an *essential* feature of obdiplostemony; not the cause of the latter condition and not universally accompanying it. Floral diagrams illustrating the difference between the author's interpretation of the gynæcium and that of the monomorphic view are given for various genera belonging to the 19 families.

A. W. E.

Carpel Polymorphism.—E. R. SAUNDERS ("On Carpel Polymorphism, IV," *Ann. Bot.*, 1931, **45**, 91–110, 45 figs., 4 diagrams). In certain genera of the Sterculiaceæ investigated a study of the vascular anatomy shows that the syncarpous gynæcium is two-whorled, the outer carpels being solid and sterile, the inner semi-solid and fertile. In the *Sterculieæ*, longitudinal splitting of the semi-solid carpels between the twin bundles of the fertile cord leads to the resolution, while still in the flowering stage, of the syncarpous, pentamerous gynæcium into five separate ovaries. The individual ovary, outwardly monomerous, is in reality constructed of ½ 1 ½ carpels. This accounts for the characteristic venation scheme, which, on the view that each ovary was formed of a single carpel, remained an unexplained anomaly. Genera with the full number of floral whorls are consistently obdiplostemonous owing to carpel polymorphism. In the *Sterculieæ* the five coloured perianth members are not homologous with the sepals of a two-whorled perianth, but each corresponds to a sepal bordered on each side by a half petal. These may aptly be termed tepals. In types having a perianth of tepals and a pentamerous gynæcium the sterile carpel cords, loculi, and stigma rays stand in line with the tepals, and the fertile carpels on the alternate radii (*Sterculieæ* and *Fremontia*). When both staminal whorls are present, and are borne on a gynophore, the outer stamen groups are antetepalous and the inner single stamens alternitepalous (most *Sterculieæ*); but in *Cola*, with no second staminal-whorl, the paired stamens of the outer whorl alternate with the tepals. *Thomasia* represents an intermediate stage in the transition from a perianth of two whorls to one of one whorl. Although the petals, as such, have almost disappeared, and the other members of the perianth are of tepal form, the flower has remained obdiplostemonous. In genera lacking antesepalous staminodes, but having both calyx and corolla, the fertile stamen groups are still superposed on the petals, as in the complete flower, but the sterile carpel cords, loculi, and stigma-rays stand in line with the sepals (*Hermannia*). The manner of origin of the vascular cords for the members of the antepetalous stamen-groups in the flower of *Pterospermum* suggests that deduplication in the andrœcium is brought about, not by *lateral* branching, but by *successive bifurcation*, the odd number of members (often three) eventually constituting each group being due to subsequent degeneration of one of the division products.

A. W. E.

A Refutation of the Theory of Carpel Polymorphism.—A. J. EAMES ("The Vascular Anatomy of the Flower with Refutation of the Theory of Carpel Polymorphism," *Amer. Journ. Bot.*, 1931, **18**, 3, 147–88, 29 figs.). The flower is a determinate stem with appendages, the pedicel and receptacle having typical stem structure, and the appendages being like leaves in their anatomy. The sepals are, with few exceptions, anatomically like leaves and are, morphologically, bracts and not sterile sporophylls. The petals are, morphologically, sometimes leaves like the sepals, but more often appear to be sterile stamens. In the stamens it seems probable that the single-trace condition has been derived from the three-trace condition found in a few primitive groups. The carpels seem to have had,

primitively, three traces, the one trace and the more-than-three trace conditions being derived. The effects of fusion, both cohesion and adnation, upon the vascular skeleton are demonstrated by examples. The external fusion of organs ultimately results in the fusion (phylogenetically) of those vascular tissues of the organs concerned which lie close to one another, either radially or tangentially. That is, not only are the organs or parts of organs " congenitally concrescent," but certain vascular tissues are also so fused, and evidence of this fusion may be obscure or lacking. The comparative anatomy of the gynæcium throughout the range of Angiosperms does not support the theory of carpel polymorphism. Carpel specialization, reduction, and loss have, indeed, occurred freely, but that modification along the lines proposed under the polymorphism theory has taken place is in no way borne out by the vascular skeleton. The theory of carpel polymorphism is said to be clearly fallacious on the following grounds :—(*a*) It fails to take into account the known anatomy of stems and leaves, neglecting the fact that a flower is a leafy stem ; (*b*) it overlooks the determinate aspect of the flower stem and the consequent modification of the tip of the vascular cylinder, and therefore interprets bundles of the stele as traces of carpels ; (*c*) it fails to take account of the effect of cohesion upon the vascular skeleton ; (*d*) its anatomical basis of interpretation is extraordinarily inconsistent ; (*e*) it emphasizes the great value of vascular tissue in determining fundamental morphology, yet, in practice, freely overlooks or discards much such tissue ; (*f*) it claims to explain gynæcium structure in a " simple " way and to remove all the " difficulties " of the older interpretation, yet its interpretations are often more complex than those of the accepted view, and involve inconsistent explanations ; (*g*) It has mistaken analogous for homologous structure, and taking the structural condition in a highly specialized family, has read this into simpler forms.

A. W. E.

The Phylogeny of Disk-Formation.—E. DAUMANN (" Zur Phylogenie der Diskusbildungen. Beiträge zur Kenntnissder Nektarien II (*Hydrocharis, Sagittaria, Sagina*)," *Beih. Bot. Centralbl.*, 1931, **48**, 183–208, 42 figs.). In *Hydrocharis Morsus-ranæ, Sagittaria sagittifolia*, and *Sagina decumbens*, the more intensive is the secretion of nectar by the perianth-segments the more far-reaching appear to be the degenerative changes which the segments concerned undergo, with the exception of the nectary-tissue itself. This agrees with what takes place in *Calycanthus florida* and *Aglaonema hospitum*, where the reduction of fertile stamens to staminodes is accompanied by the faculty of nectar-production. Comparative observation of a large amount of flowering material of *H. Morsus-ranæ* and *S. sagittifolia* showed a tendency for solitary members of the andrœcium and gynæcium to differ from the normal type, the principal variations being in the direction tending towards the development of a more or less homogeneous disk. These observations give a valuable general standpoint for the morphological interpretation, and hence the phylogeny, of disk-formation in general. In *H. Morsus-ranæ* the nectaries of the female flowers are not emergences of the inner perianth-segments, but members of the innermost andrœcial whorl. In the male flowers the centrally placed nectary, at first sight fundamentally different from that of the female flowers, is shown to be formed by the union, and more or less profound modification, of the three andrœcial nectaries and the style. In *S. sagittifolia* the bases of the fertile carpels and stamens function as weakly secreting nectaries. On the staminodes and pistillodes the development of this nectary-tissue is stronger, and the formation of nectar greater, than in the corresponding tissues of the fertile carpels and stamens.

A. W. E.

CRYPTOGAMIA.

Pteridophyta.

Chloroplasts of Selaginella.—ROBERTA MOHLING MA ("The Chloroplasts of Selaginella," *Bull. Torrey Bot. Club*, 1930, **57**, 277–84, 1 pl.). A study of the chloroplasts of the cells of the assimilative leaves of *Selaginella apus*, *S. Riddellii*, and *S. Wrightii*. The number of the plastids in a cell varies. The plastids contain spindle-shaped bodies which stain red or blue; the blue-staining bodies are shown to be starch, while the red-staining are of protein. Some 4 to 20 of these bodies are aggregated towards the centre of the plastid, being similar in size and shape, and differing only in their reaction to stains. It is probable that some close relation exists between them; the one kind may arise from the other. As starch grains increase, the protein bodies gradually disappear. In regions of active growth, where the demand for carbohydrate is correspondingly great, very little starch is visible, but the protein bodies are common. In mature cells during photosynthesis, starch grains are in excess and protein bodies almost absent. Intermediate bodies with mixed red and blue stain have been noted among the other bodies. These results are discussed and compared with what has been described for *Iscëtes* and *Anthoceros*. A. G.

Antheridial Dehiscence.—M. ELIZABETH HARTMAN ("Antheridial Dehiscence in the Polypodiaceæ," *Bot. Gaz*, 1931, **91**, 252–76, 27 figs.). A morphological and micro-chemical investigation of antheridial dehiscence in the Polypodiaceæ, based on living material. A characteristic mode of dehiscence is the extrusion of the intact cap-cell, as described by Schlumberger. One significant modification of this is the extrusion of the cap-cell contents as a granular mass. In all cases there is a hole or pore in the outer membrane of the antheridium. A star-shaped rupture of the apical cell does not occur. The wall cells are active in the opening; but it is the swelling of the spermatogenous mass that seems to be primary in causing the initial tear in the outer membrane. The pectin of the sperm mother-cell membranes apparently causes the swelling of the spermatogenous mass. The wall cells are also partly pectic in nature, a fact which may account, at least partially, for their ability to swell. The cap cell is markedly devoid of cellulose; this may explain the evanescent nature of its inner membrane. The presence of sugars in the peripheral cells is indicated. *Athyrium Filix-fœmina* sometimes has the cap-cell divided. A. G.

Asiatic Ferns.—CARL CHRISTENSEN ("Asiatic Pteridophyta Collected by Joseph F. Rock, 1920–24," *Contrib. from U.S. National Herbarium*, 1931, **26**, pt. 6, I–XII, 265–337, 17 pls.). A report on the pteridophyta collected by Joseph F. Rock in south-eastern Asia, principally on the Burma-Yunnan border and over a wide area in Yunnan; to it are added some small collections from Siam and South-East Tibet. The whole collection contains 293 species; of these, 275 are found in Burma, Yunnan, and Tibet, 1 in Szechwan, and 60 in Siam. There are 6 species new to science, 13 new to China, several new to Yunnan, but previously found in Kweichou or Szechwan, 11 new to Burma and the Indian Empire. Incidentally, the report is a revision of the determinations of older authors, Hooker, Baker, Clarke, Beddome, Christ, as well as Hieronymus. Various keys and critical notes are interspersed. A. G.

Ferns of Japan and Corea.—T. NAKAI ("Notulæ ad plantas japoniæ et koreæ, XL," *Bot. Mag., Tokyo*, 1931, **45**, 91–105). Descriptions of eight new species of ferns from Corea and two from Japan, together with some new varieties, new combinations, and critical notes. A. G.

Bryophyta.

Plastid in Polytrichum.—T. Elliot Weier ("A Study of the Moss Plastid after Fixation by Mitochondrial, Osmium and Silver Techniques. I. The Plastid during Sporogenesis in *Polytrichum commune*," *Travaux Biol. Inst. J. B. Carnoy, Louvain*, 1931, no. 8, 260–90, 4 pls.). This paper contains an introduction; a description of technique; a description of plastid development after fixation: (*a*) by mitochondrial techniques; (*b*) by the method of Da Fano; (*c*) by the method of Kolatchev; vital studies on plastid development; a comparison between the Golgi body present in animal tissue (*Euschistus*) and the plastid of *Polytrichum commune*; a discussion of cytoplasmic bodies other than the plastid; a summary of the results. A. G.

East Baltic Mosses.—N. Malta ("Übersicht der Moosflora des Ostbaltischen Gebietes II. Laubmoose [Andreæales et Bryales]," *Acta Horti Botanici Universitatis Latviensis, Riga*, 1930, **5**, 75–182, 19 figs.). A systematic account of the mosses of Latvia and Esthonia, with the general distribution and habitat of each species, and often with critical notes and figures. A. G.

Mosses of Illinois.—Charles E. Montgomery ("Ecology of the Mosses of Grand de Tour Region of Illinois, with Special Reference to *p*H Relations," *Bot. Gaz.*, 1931, **91**, 225–51, 10 tables). A study of the relation of mosses to their habitat in this region—of the H-ion concentration of the mosses and the top soil to which they are attached, and of the H-ion concentration of the soil 2–3 cm. deep. The conclusions reached are that mosses seem to have an H-ion range within which they can grow, the optimum growth occurring at the middle of the range. On sandy soils the mosses are mostly acid-loving types, so also on hill-tops and on sandstone, but at the bases and on the sides of hills they may be alkaline. Tree mosses are between neutral and alkaline; but those on old wood are acid. On limestone and on thin soils overlying it the mosses are alkaline, as also on the banks of small streams. Most acid-loving mosses are acrocarps; most alkaline mosses are pleurocarps. There is a close correlation of *p*H between the mosses and the substratum to which they are attached; and some correlation between them and the deeper soil, but not so close. Moisture supply is an important factor in moss growth even when the H-ion concentration is suitable. Mosses in mixed groups have a similar *p*H adjustment. The district explored gives some indications that the mosses have followed in successions. Soil tests conform to the usual type. Hill-tops and upper flats are acid; lower slopes are neutral to alkaline. Mosses have adjusted themselves to these conditions rather closely; and they have the same general relations to their substratum, in respect of H-ion concentration, as the phanerogamic plants. A. G.

Indian Mosses.—P. Brühl ("A Census of Indian Mosses, with Analytical Keys to the Genera referred to in the Census, as well as All the Genera dealt with in the Second Edition of Prof. Brotherus's account of the *Musci veri* in Engler and Prantl's 'Pflanzenfamilien,'" *Records Botan. Survey of India, Calcutta*, 1931, **13**, no. 1, 1–135, no. 2, i–iv, 1–152). The first part is mainly occupied by a comprehensive list of 2,471 mosses recorded for India, Ceylon, Malay Peninsula, Sumatra, Java, French China, Persia, Turkestan, Kurdistan, and the Caucasus, based upon Brotherus's great work on mosses in Engler's "Pflanzenfamilien," supplemented by the publications of Max Fleischer, H. N. Dixon and others. The distribution of each species is given. In an appendix are included lists of new species named by K. Müller and by Brotherus, and distributed by E. Levier, but not described.

The second part of the work consists of a key to the mosses of the whole world, based, so far as is possible, on vegetative characters; the general idea is to facilitate the detection of the genus, and then refer the student to the proper page of Brotherus's work for the determination of the species. A. G.

Japanese Hepaticæ.—Y. Horikawa ("Studies on the Hepaticæ of Japan, IV," *Journ. Sci., Hiroshima Univ.*, 1931, ser. B, div. 2, **1**, 13–35, 2 pls., 10 figs.). Descriptions of 12 species, representing 9 genera of Hepaticæ gathered in Japan; 11 of these are new to science. A. G.

Thallophyta.

Algæ.

Glœotrichia.—V. I. Poliansky ("Sur la question des stades de développement chez *Glœotrichia natans* (Hedw.) Rabenh.," *Bull. Jard. Bot. Princ. de l'U.R.S.S.*, 1930, **29**, 265–99, 2 pls.). An investigation of the variations of *Glœotrichia natans*. The form and dimensions of the cells are an important systematic character, and it is necessary to study the changes of this characteristic which occur during the life of *Glœotrichia natans*. *Glœotrichia* has two different stages in its development, which are named Status *Pseudorivularia* and Status *Euglœotrichia* by the author. Status *Pseudorivularia*, in principle, differs but little from true *Rivularia*, which never forms spores. The author insists upon the importance of an investigation of Status *Euglœotrichia* and Status *Pseudorivularia*, because it is at present quite impossible to determine the genus *Glœotrichia* in some cases. A. G.

Russian Cyanophyceæ.—K. K. Kossinskaja ("Enumération critique des cyanophycées, recueillies en été 1928 aux environs de la Station biologique du Donetz-Nord," *Bull. Jard. Bot. Princ. de l'U.R.S.S.*, 1930, **29**, 108–29, 1 pl.). A list of 33 Cyanophyceæ collected in the waters of the River Donetz, in the Province of Kharkov. A new species of *Merismopedia* is described. A. G.

Siberian Algæ.—T. G. Popova ("Zur Algenflora der Mineralwasserbecken West-Sibiriens," *Bull. Jard. Bot. Princ. de l'U.R.S.S.*, 1930, **29**, 237–64, 2 pls.). An account of the algæ of some weakly alkaline lakes in West Siberia. In particular the flora of Lake Bolshoë Petuchovskoe, on the south-western border of the Kulundinsk forest, is described in detail. The salinity is 1 to 3·5° B.; and the lake exhibits a remarkable development of a thick bottom-layer 5–6 cm. thick, formed of an assemblage of several Cyanophyceæ, and upon it lie a multitude of diatoms. In days of intensive assimilation this algal stratum rises to the surface, and becomes driven to the shore, where wide deposits are cast. The plankton of the lake is poor. From the beginning of July *Characiochloris* abounds epiphytically on the shells of Crustacea, and colonies of *Oocystis salina* appear in the plankton. *Phormidium*, *Plectonema*, *Anabæna*, etc., grow attached to reeds of *Phragmites* on the southern margins of the lake. A. G.

Devonshire Diatoms.—G. T. Harris ("The Freshwater Bacillariales of Devonshire," *Trans. Devon. Assoc. Sci.*, 1930, **62**, 285–310). The paper is the result of five years' systematic examination of the freshwater diatom flora of Devonshire. The county was conveniently divided into a number of stations, and the species obtained therefrom identified and catalogued, together with a note as to environment and frequency. Excluding a number of doubtful ones, 232 species were admitted to the list; this represents approximately 92 p.c. of the species given by other

authors for the whole of the British Isles. Schütt's classification was adopted for the catalogue. The author noticed that, with one or two notable exceptions, the species were distributed with a certain amount of indifference as to environmental conditions, and also frequency in what may be called "species-ponds," that is, the prodigious production or concentration of one particular species or genus in one pond. The peat beds of Dartmoor yielded practically negative results when examined for diatoms, owing to their altitude and the low silica content of the water. N. I. H.

Volvocales.—GILBERT MORGAN SMITH ("Notes on the Volvocales, I–IV," *Bull. Torrey Bot. Club*, 1931, **57**, 359–70, 2 pls.). The author first discusses the species of *Eudorina*, giving a key to the five species of the genus, three of these being new species, previously confounded with *E. elegans* Ehrenb. He then gives his views as to the phylogeny of the higher colonial Volvocales. Next he gives an account of *Pandorina charkowiensis* Korshikow, which has been gathered several times in California. And finally he gives an account of *Gonium formosum* Pascher and *G. sociale* (Duj.) Warming. A. G.

Spirogyra.—HAZEL SAUNDERS ("Conjugation in *Spirogyra*," *Ann. Bot.*, 1931, **45**, 233–56, 8 figs., 4 diagrams). An account of conjugation in *Spirogyra*, with particular reference to the changes that take place prior to the formation of conjugation tubes. The early stages of conjugation in *S. Weberi*, *S. varians* and *S. catæniformis* are described, and in general confirm Czurda's conclusions. The earliest stages can only be found in fresh material. The conjugating filaments at first lie in contact glued together by mucilage. Papillæ emerge later from one of each of the pairs of opposite (partner) cells that are glued together. The first-formed papilla may arise in either filament, and is independent of the sex of the latter. The opposite papilla arises at the place of contact with that first formed. The two papillæ are in contact from the first moment of their formation, and by their growth in length the filaments are gradually pushed apart. The apices of the papillæ become flattened and absorbed, and the familiar ladder-like appearance of the conjugating filaments is obtained. During the early stages of conjugation in *S. varians* the nucleus moves from the centre of the cell to the side remote from the tube. It is only in the later stages that a differentiation of sex can be discerned, as the female cells then become swollen. A. G.

Rhizothallus.—PIERRE DANGEARD ("Sur un genre nouveau de Trentépohliacées récolté en Islande (*Rhizothallus* nov. gen.)," *Bull. Soc. Bot., France*, 1931, **78**, 91–5, 2 figs.). An account of the characters of a new alga genus, *Rhizothallus*, which was found in 1928, in wide patches, beside a tepid spring not far from Reykjavik, in Iceland. It is remarkable for its subterranean feltwork of colourless rhizoids, from which arise a dense array of erect green aerial branches, rarely branched, constituting a cespitose carpet about 1 mm. thick. Its cytological characters and habit point to affinity with *Trentepohlia*, but it differs from the latter in having a terrestrial habitat. The only species is *R. islandicus*. A. G.

Wall of Vaucheria.—LADLEY HUSTED ("Cell Wall of *Vaucheria geminata*," *Bot. Gaz.*, 1931, **91**, 219). The cell wall of *Vaucheria geminata* has been described by M. E. Wurdack, in *Ohio Journ. Sci.*, 1923, **23**, 181–91, as being composed of two layers, pectose on the outside, cellulose within. The present author has come to a different conclusion; he holds that the cell wall of this alga is composed of three layers: an outer layer of pectic compounds, a middle layer of cellulose, and an extremely thin inner layer either of pectose substances or of cellulose heavily impregnated with pectose. A. G.

Auvergne Algæ.—Abbé Pierre Frémy ("Cyanophycées d'Auvergne," *Bull. Soc. Bot., France*, 1931, **77**, 672–81). A systematic list of all the Cyanophyceæ that have hitherto been collected in the Auvergne region by the author and others. It comprises 27 species of Chroococcales, 3 Chamæsiphonales, and 69 Hormogoneales; 26 of these species and some varieties are new records for the Auvergne, and a new variety of *Calothrix* is described. Some biological notes are added on the algal flora of oozing rocks and on the Cyanophyceæ of the saline exudation of the Saint-Nectaire neighbourhood, where occurs a halophilous flora of phanerogams, bryophytes, and diatoms. A. G.

Freshwater Algæ of Sweden.—Folke Lundberg ("Beiträge zur Kenntniss der Algenflora von Schweden. I. Über das Phytoplankton einiger Seen in Dalarne," *Botaniska Notiser*, 1931, 269–96, 17 figs.). A systematic list of phytoplankton from some lakes in Dalarne, preceded by an account of the physical geography of the lakes in question. Included in the list are 16 Cyanophyceæ, 9 Peridinieæ, 6 diatoms, 28 Chlorophyceæ, 93 desmids, and numerous varieties. The novelties are four new species and four varieties. A. G.

Algæ of Carinthia.—Günther Beck-Mannagetta ("Die Algen Kärntens. Erste Grundlagen einer Algenflora von Kärnten," *Beihefte zum Botanischen Centralblatt*, 1931, **47**, 211–342, 35 figs.). A systematic list of all the freshwater algæ hitherto recorded for the Province of Carinthia, amounting to about 200 genera, nearly 1,000 species, and 500 varieties and forms. A. G.

Russian Charophyta.—Jan Vilhelm ("Ad characearum Europæ orientalis et Asiæ cognitionem additamentum," *Bull. Jard. Bot. Princ. de l'U.R.S.S.*, 1930, **29**, 582–96). A list of 64 species, varieties and forms of Characeæ preserved in the herbaria at Leningrad and Tomsk, having been collected in Russia and Siberia, and submitted to the author in Prag. Seven new forms are described. A. G.

Schizymenia and Turnerella.—E. Chemin ("Les cellules glandulaires dans les genres *Schizymenia* et *Turnerella*," *Bull. Soc. Bot., France*, 1931, **77**, 642–53). Glandular cells occur superficially in all species of *Schizymenia* and, fresh or dry, they stain turquoise-blue on application of cresyl-blue; they contain neither iodine nor iodides, and are thereby distinguished from the glandular cells of *Bonnemaisonia*, *Asparagopsis*, *Falkenbergia* and *Trailliella*. They do not stain with fluorescin like *Antithamnion* and *Antithamnionella*. They serve as a character for distinguishing *Schizymenia* from *Callymenia*, *Dilsea*, *Halymenia* and *Halarachnion*, which often are similar in form. The genus *Turnerella* also has glandular cells which take the cresyl-blue stain; but they are situated more deeply in the cortex and can only be observed in transverse sections. Their contents are yellow, much as in *Falkenbergia*. *Turnerella* might be referred to *Schizymenia*, were it not that the carpostomes appear very much later than in *Schizymenia*, and the development of the cystocarps shows *Schizymenia* to belong to the Cryptonemiales, and *Turnerella* to the Gigantinales. A. G.

Phæosporeæ.—P. Kuckuck ("Fragmente einer Monographie der Phæosporeen. Nach dem Tode des Verfassers herausgegeben von W. Nienburg," *Wissenschaftl. Meeresuntersuchungen*, 1929, N.F. Abt. Helgoland, **17**, no. 4, 1–93, 155 figs.). So far as was possible, the residual manuscripts and drawings prepared by the late Dr. Paul Kuckuck, of Heligoland, during his long studies of the Phæosporeæ, have been published under the editorship of W. Nienburg. Naturally, there are gaps in the results; and the Ectocarpaceæ, in which group Kuckuck had

from the very first been keenly interested, had to be omitted, since the manuscripts can only be adapted for publication after revision and completion by a competent specialist. A. G.

Bactrophora.—JOSEPHINE E. TILDEN and ANNA PARKER FESSENDEN ("*Bactrophora irregularis*, a New Brown Alga from Australia," *Bull. Torrey Bot. Club*, 1931, **57**, 381–6, 2 pls.). *Bactrophora* is a genus of brown algæ founded by J. G. Agardh, in 1880, upon three species collected on the coast of Australia by W. H. Harvey a quarter of a century earlier, two of which were referred to *Mesogloia*. The present authors describe another species, *B. irregularis*, from Kiama, N.S. Wales, and describe it at some length. The genus belongs to the family Chordariaceæ. A. G.

Stypocaulon.—E. MARION HIGGINS ("A Cytological Investigation of *Stypocaulon scoparium* (L.) Kütz., with Especial Reference to the Unilocular Sporangia," *Ann. Bot.*, 1931, **45**, 345–53, 1 pl.). The result of this investigation is as follows: The general morphology and the details of the vegetative nuclear division in *Stypocaulon scoparium* were found to be in close agreement with work already published. The chromosome number in the vegetative cells is 32. The origin and development of the unilocular sporangia were investigated and the cytology studied in detail. The first nuclear division in the unilocular sporangial mother-cell is heterotypic, giving rise to nuclei with the reduced number of chromosomes, which throughout the subsequent divisions have been found to be 16. A. G.

Desmarestia.—M. CHADEFAUD ("Le vacuome et les physodes de deux *Desmarestia*," *Bull. Soc. Bot., France*, 1931, **78**, 41–6, 1 fig.). From a study of the cytology of *Desmarestia Dudresnayi* and *D. ligulata* the author draws the following conclusions. These two species are remarkable among all algæ for the characters of their vacuome, and in particular for their specialized vacuoles. *D. ligulata* contains physodes in all its cells; *D. Dudresnayi* is markedly different in having physodes neither in its superficial nor in its vesiculous cells; it is impossible at present to explain their absence. As to the large specialized vacuoles, they appear to contain potassium oxalate. A. G.

Bermuda Algæ.—LAWRENCE ROGERS BLINKS and ANNE HOF BLINKS ("Two Genera of Algæ New to Bermuda," *Bull. Torrey Bot. Club*, 1931, **57**, 389–96, 2 pls., 1 fig.). Two genera new to the flora of Bermuda are *Halicystis* (not previously recorded from the Western Atlantic), and *Corynomorpha*, found in Florida by W. H. Harvey 80 years ago, and subsequently in Guadeloupe. In the present paper *Halocystis Osterhoutii* is described as a new species, and is discussed at some length. In the past it has been confused with *Valonia ventricosa*. There is also a note on the rare *Corynomorpha clavata* J. Ag., originally described from Key West by Harvey in 1853. A. G.

Canadian Algæ.—MURIEL V. ROSCOE ("The Algæ of St. Paul Island," *Rhodora*, 1931, **33**, 127–31, 1 pl., 1 fig.). A list of 39 algæ collected on the rocks of St. Paul Island in Cabot Strait, Gulf of St. Lawrence, in the summer of 1929. It is introduced by an account of the physical geography of the island, its climates, tides and collecting grounds. A. G.

Japanese Algæ.—YUKIO YAMADA ("Notes on Some Japanese Algæ—II," *Journ. Fac. Sci., Hokkaido Imperial Univ.*, 1931, ser. v, **1**, 65–76, 5 pls., 3 figs.). Descriptions of seven new species of Japanese algæ, with a key to the species of

Padina found in Japan and a revised description of *P. australis* Hauck. *Besa gracilis* occurs as a small excrescence on *Hildenbrandia*, as in the case of its rare congener in California, but what its true relation to the *Hildenbrandia* may be is as yet unknown. A. G.

Fungi.

Study of Pythium.—FREDERICK K. SPARROW ("Observations on *Pythium dictyospermum*," *Mycologia*, 1931, **23**, 191–203, 1 pl., 1 text-fig.). The fungus has been found in Europe on several species of *Spirogyra*. Sparrow describes its first appearance in the United States in a laboratory culture of *Spirogyra crassa*. He noted the golden reticulate oospores and, later, the sporangia. A careful study has provided new details of development and morphology. He describes the formation of the mycelium and its entrance into the cell, the non-sexual reproduction by means of sporangia and zoospores, also the penetration of the alga by zoospores; these bodies come to rest on the alga, lose their cilia and become spherical, from the surface a fine hyaline tube pierces the algal cell and develops into a fully formed hypha. Sexual reproduction is also described at length, especially the structure of the oospore. A. L. S.

New Species of Pythium.—F. K. SPARROW ("Two New Species of *Pythium* parasitic in Green Algæ," *Ann. Bot.*, 1931, **45**, 257–77, 1 pl., 2 text-figs.). The new *Pythium* species occurred in a pond near Cambridge, Massachusetts: one growing in filaments of *Rhizoclonium* (*Pythium adhærens*), the other (*P. angustatum*) in *Spirogyra crassa*. Both species are new to science. The two fungi have been studied as to their vegetative developments and their reproduction. *P. adhærens* has much coarser mycelium than the other, and produces many large pyriform appressoria. The oospores were found after three months. The zoospores produced from the germinating oospores come to rest and germinate, giving rise to more zoospores. Experiments were made to test the sexuality of spores and mycelium, but the evidence is not yet considered to be convincing. A. L. S.

Study of Pythiaceæ.—C. P. SIDERIS ("Taxonomic Studies in the Family Pythiaceæ. I. *Nematosporangium*," *Mycologia*, 1931, **23**, 252–95, 12 text-figs.). Attention was drawn to this group of fungi during a research into a root-disease of pine-apple known as pine-apple wilt, several of the causal agents being recognized as members of the Pythiaceæ. The morphology of the different genera of the family is described—the type of mycelium and the reproductive bodies, the prosporangium (plasmatoözoses), exit tube and zoosporangium. These are described and compared for the three genera *Pythium*, *Phytophthora*, and *Nematosporangium*. The larger part of the paper deals with *Nematosporangium*. There is a full general description of the development in that genus, as observed in cultures, and comparison is made with the other genera. Sideris describes 15 species, most of them new to science, the large majority found on diseased roots of pine-apple (*Ananas sativus*), as well as on a number of other roots of economic plants. The writer has made an exhaustive study of these little-known fungi. A. L. S.

Light Influence on Phycomyces.—E. S. CASTLE ("Phototropic 'Indifference' and the Light-Sensitive System of *Phycomyces*," *Bot. Gaz.*, 1931, **91**, 206–12, 2 text-figs.). The writer describes the apparatus used in his experiments. The aim was to examine the influence of light on the sporangiophores. Indifference was found to be due to unilateral illumination failing to evoke a differential acceleration of growth on the two sides of the sporangiophore, and is not due to the absence of photic excitation. A. L. S.

Study of Aspergillus.—ADALBERT BLOCHWITZ ("Zur Morphologie von *Aspergillus*," *Ann. Mycol.*, 1931, **29**, 92–101, 4 text-figs.). Blochwitz writes on several aspects of development in the cultures of *Aspergillus*. He comments on the formation of simple or branched conidial stalks and on the formation of the sterigmata. Endogenous conidial formation, he considers, does not take place. He describes many variations due to culture conditions, and deprecates the describing of new species on abnormal growths, instances of which he gives. The formation of coremia is also often misunderstood, their appearance being frequently due to the kind of culture media used. A. L. S.

Discomycetes on Salix.—J. A. NANNFELDT ("Contributions to the Mycoflora of Sweden," *Svensk Bot. Tidskr.*, 1931, **25**, 1–31, 5 text-figs.). A number of Discomycetes, under different names, have been reported from willow leaves. One of the earliest was described by Fries as *Excipula sphæroides*, others referred to the genera *Pyrenopeziza, Pseudopeziza, Mollisia* and *Trochila*. Nannfeldt has examined these different fungi in the field as well as the type specimens, and now publishes his results. He finds three genera represented—*Drepanopeziza*, *Pyrenopeziza* and *Nævia*, and also conidial stages with 1-septate hyaline spores belonging to *Marssonia*. Full descriptions are given of the different specimens, and the reasons for his proposed changes in nomenclature. A long list of authors cited is appended. A. L. S.

Cup-Fungi.—FRED J. SEAVER ("Photographs and Descriptions of Cup-Fungi—XIV," *Mycologia*, 1931, **23**, 247–51, 2 pls.). Seaver has determined as members of *Chloroscypha* gen. nov. small greenish-white Discomycetes that have been found on the foliage of conifers (*Thuja*, *Sequoia* and *Juniperus*) and are evidently parasitic. The forms on the various hosts differ sufficiently to rank as separate species. The paper is published as a preliminary to a full account of North American cup-fungi. A. L. S.

Sooty Moulds.—K. B. BOEDJIN ("Notes on Some Sooty Moulds," *Bull. Jard. Bot., Buitenzorg*, 1931, **11**, 220–31, 1 pl.). The author has given a general account of these disfiguring leaf-moulds, which live on the secretions of aphides and scale-insects. The conidia-bearing mycelia are easily produced on artificial media; the ascigerous stage is, however, difficult to cultivate. Boedjin has studied the various types of formation; he describes in detail *Capnodium Theæ* nov. sp., and three other species which he has revised as to their appropriate genera. One of these, *Phycopsis Treubii*, has been wrongly considered a species of *Atichia*, but it lacks the star-shaped thallus of that genus. The asci were few, in a single row near the periphery, and each one isolated within the tissue; no paraphyses are mentioned. A bibliography relating to "fumagine" fungi is given. A. L. S.

Red Yeasts.—KAZUO OKUNUKI ("Beiträge zur Kenntniss der rosafarbigen Sprosspilze," *Jap. Journ. Bot.*, 1931, **5**, 285–322, 1 pl., 22 text-figs.). Most of the coloured yeasts experimented with were secured from the air; others were found in the soil of the Botanic Gardens of Tokio. Okunuki thus secured 14 different forms, which he grew in a number of different media, both liquid and solid, and full details of all the cultures are given. Finally he describes 7 new species. As none of these formed true mycelia, he has classified them under the genus *Torula*. A. L. S.

Fertilization in Ascomycetes.—H. C. I. GWYNNE-VAUGHAN and H. S. WILLIAMSON ("Contributions to the Study of *Pyronema confluens*," *Ann. Bot.*, 1931, **45**, 355–71, 3 pls., 7 text-figs.). The authors give careful particulars as to the

collecting, growing, and preparing of material for examination. They so contrived that the developing ascocarp was secured at all stages, hardened, stained, and kept indefinitely until examination could be made. The spores germinated immediately, and may even germinate in the ascus; the new ascocarp may arise from single spore cultures. The male and female organs arise from separate hyphæ, which are multinucleate; both organs are multinucleate, containing from 100 to 200 nuclei. On copulation between antheridium and oogonium the antheridial nuclei pass into the oogonium; there the male and female nuclei fuse in pairs in the resting stage. After fertilization ascogenous hyphæ develop and the nuclei pass in; later these lie in single file in the branches and divide simultaneously; after division the daughter nuclei are separated, each by a vacuole and then by a cell wall, so that there appears a central cell with two nuclei and end cells with one each. The binucleate central cells bud out and form a crozier, from the penultimate cell of which the ascus is produced. In this cell two diploid nuclei with 12 chromosomes indicate that sexual fusion takes place before the formation of the ascogenous hyphæ. When the two diploid nuclei of the crozier fuse, they constitute the tetraploid definitive nucleus of the ascus; the first division (meiotic) shows 12 gemini, and at the next division a second reduction takes place. The haploid number of chromosomes is 6, as seen in the germinating spores, in the paraphyses, etc., and again in the second and third divisions in the ascus, all showing that the haploid number is 6. Continual comparison is made with the work of other students, and a list of works consulted is added. A. L. S.

The Genus Helicoceras.—David H. Linder (*Ann. Miss. Bot. Gard.*, 1931, **18**, 1–8, 1 pl.). *Helicoceras* is a genus of Hyphomycetes with coiled spores and dark in colour. It was originally known as *Gyroceras*, but as that name had to be dropped, the new designation has been established by Linder. A careful description is given of the genus and of the four species. The type species *G. Celtidis* is from Sicily. The species, as a rule, are widely distributed. A. L. S.

Notes on Helicosporæ.—David H. Linder ("Brief Notes on the *Helicosporæ*, with Descriptions of Four New Species," *tom. cit.*, 9–16, 1 pl., 2 text-figs.). Since the publication of Linder's monograph of the Helicosporous *Fungi Imperfecti* several species have been reported in America, most of them new to science; they belong to the genera *Helicosporum* and to *Helicoma*. A. L. S.

Study of Cicinnobolus.—Chester W. Emmons ("*Cicinnobolus Cesatii*, a Study in Host-parasite Relationships," *Bull. Torrey Bot. Club*, 1930, **57**, 421–41, 3 pls.). *Cicinnobolus* has long been known as a parasite of the mildew *Erysiphe*. It belongs to the Sphæropsideæ, with pycnidia and colourless spores. Emmons has made an exact cultural study of the fungus. He finds that it grows as a virulent parasite within the *Erysiphe* hyphæ, using up the contents and finally destroying the fungal host; it then passes to the leaf on which the mildew was growing and attacks the leaf tissues. The host, in this case, was *Helianthus tuberosus*. The formation of pycnidia is described; they are developed most commonly in the conidiophores or ascocarps of the host, which are speedily destroyed, and then the parasite gathers food from adjacent mycelia. A further paper is promised on the development of the perfect form of the fungus. A. L. S.

Mulberry Rust.—Makoto Hiura ("Observations and Experiments on the Mulberry Rust caused by *Aecidium Mori* Barclay," *Jap. Journ. Bot.*, 1931, **5**, 253–72, 3 pls., 3 text-figs.). The rust occurs throughout the mulberry region of Japan, and causes considerable damage to the trees, inducing hypertrophy of the young

shoots; leaves, petioles, stems and flowers are also commonly infected. Hiura deals with the various symptoms of the disease—its development in the host, etc. He found that æcidiospores were the infection agents; no other form of the fungus has been found. The disease can be controlled by removing infected shoots.

A. L. S.

Witches-Broom Rust.—E. ULBRICH ("Ueber den Hexenbesenrost der Berberitze, *Puccinia Arrhenatheri* (Kleb.), Erikss. (*Aecidium graveolens* Shuttl.)," *Notizbl. Bot. Gart. und Mus. Berlin-Dahlem*, 1931, **11**, 124–8). The author comments on the appearance of witches broom in considerable abundance on the barberry in Brandenburg in 1926. There had been no record or sign of such growths in Germany for many years, and, as the locality was constantly worked over by himself and others, its presence could not have been overlooked. In order to clear out the disease, the branches attacked (or the whole shrub) were destroyed. In 1928 it was rare; in 1930 there was no trace of the rust in the locality.

A. L. S.

Sorghum Rust.—C. O. JOHNSTON and E. B. MAINS ("Relative Susceptibility of Varieties of Sorghum to Rust, *Puccinia purpurea*," *Phytopathology*, 1931, **21**, 525–43, 7 text-figs.). There are many varieties of Sorghum, and they differ considerably in their liability to rust disease. The authors have made a wide study of these different sorghums, mostly those of America, noting the occurrence of the rust in widely separated States. It has been recorded as far north as Indiana and Kansas. There was found to be considerable variation in the reaction to infection. Experiments were made to test infections on sweet corn, but without result.

A. L. S.

Heterothallism in Rusts.—GEORGE B. CUMMINS ("Heterothallism in Corn Rust and Effect of Filtering the Pycnial Exudate," *Phytopathology*, 1931, **21**, 751–3). The aim of the filtering experiments was to precise the part played by pycnidia in the development of rusts. As a rule, the filtering, and thus extracting the pycniospores from the exudate, resulted in the non-development of æcidia, though always, in time, a few of these appeared. The view that the exudation from the pycnia provoked an enzymatic stimulation has to be abandoned; the presence of living pycniospores is essential, and *Puccinia Sorghi*, the rust experimented on, has been proved to be heterothallic. A. L. S.

Wheat Resistance to Bunt.—ING. AGR. RAIMUNDO NIEVES ("Resistencia comparativa a la *Tilletia levis* Kuhn, del Trigo, en la Argentina," *Phytopathology*, 1931, **21**, 705–26, Spanish with English summary). The writer has made a wide study of the occurrence and virulence of bunt attacks on wheat in Argentina. The research was begun in 1928, and has entailed a vast amount of work; the comparative results are set out in tables. It is particularly in the winter-wheat area that the loss from bunt is most severe. Attempts have been made, by disinfecting seeds, to stamp out the disease, but the drastic remedies used—copper carbonate, etc.—often injure the seeds. Infection may also arrive from bunt spores in the soil. The most fatal seasons for infection are in April and May. Special attention was directed to securing strains of wheat that would be resistant. Three years of "yield experiments" indicate possibility of success in that direction. Certain strains of wheats from Hungary and a variety from Australia promise good results, and these are being crossed with other varieties. A. L. S.

Study of Rusts.—H. KLEBAHN ("Kulturversuche und Bemerkungen über Rost-pilze XVIII. Bericht (1925–30)," *Zeitsch. Pflanzenkr. und Pflanzensch.*, 1931, **41**, 209–23). Klebahn gives an account of his study of a varied series of rusts. (1) *Cronartium ribicola*: There is doubt as to the authority and occurrence of this species. The determination of Fischer is questioned; finally Dietrich is accepted as the author of the species. (2) *Puccinia Pringsheimiana*: This rust also grows on *Ribes*, and was first studied as an æcidium form on *Ribes nigrum*. The question here is whether there are a variety of host plants; further research is necessary. (3) *Puccinia triticina*: Again a question of host determination. *Thalictrum* spp., the hosts of the æcidial form, are rare in Germany, and are also alternative hosts of *Puccinia persistens* Plowr. (4) Research on spore germination in plant juice: there were no results. (5) *Puccinia Swertiæ*: This rust is a parasite of the gentian *Swertia perennis*; it appears that teleutosori and æcidia occur on the same host. (6) *Hyalospora cystopteridis*: Change of host has not been proved; it is suggested that the rust overwinters in the root-stocks. (7) *Ustilago longissima*: Successful attempts to reproduce the smut by infection are recorded. A. L. S.

Urocystis Deformations.—E. ULBRICH ("Ueber eigenartige alloiophylle Riesenformen von *Anemone nemorosa* L. mit *Urocystis*-Befall," *Notizbl. Bot. Gart. und Mus. Berlin-Dahlem*, 1931, **11**, 128–34). The author writes a description of the effect of the parasite *Urocystis* on the plants of *Anemone nemorosa*, both the vegetative parts and the flowers, the latter measuring 70 mm. across and resembling somewhat a small *Pæonia*. Information is given as to other instances of deformation, but the author states that no instance of inducing such giant forms through *Urocystis* has been recorded. A discussion follows on the fungus species, decided finally to be *U. Anemones* (Pers.) Wint. A. L. S.

Notes on New Species of Ustilaginales.—GEORGE L. ZUNDEL (*Mycologia*, 1931, **23**, 296–9). The new species of *Ustilago*, *Sphacelotheca*, *Cintractia*, and *Tilletia*, 10 in all, were received from Pretoria, S. Africa, and from Brazil. They all are parasitic on the inflorescences of various grasses. Full descriptions are given, with localities and collectors. They were examined and determined at the State College, Pennsylvania. A. L. S.

Study of Ustilaginales.—R. CIFERRI ("Quinta contributione allo studio degli Ustilaginales," *Ann. Mycol.*, 1931, **29**, 1–74, 17 text-figs.). Ciferri has examined a very large number of the different genera of Ustilagineæ. He compares species and genera from all parts of the world, giving special attention to spore measurements as they differ from host to host. In some instances he concentrates on one host genus, giving details of all the smuts that grow on the different plants. Or, again, he takes the smuts peculiar to one region, as, for instance, the "Ustilaginales of Sierra Leone." Many new species are described. The text-figures consist of diagrams representing comparative size of spores and cells. A. L. S.

Study of Ustilago Avenæ.—LAURA ALMA KOLK ("Relation of Host and Pathogen in the Oat Smut, *Ustilago Avenæ*," *Bull. Torrey Bot. Club*, 1930, **57**, 443–507, 4 pls.). Material for research was obtained by dry dusting of the spores on oat seedlings. The author notes the advance of penetration into the host tissues, the infection spreading from one tissue to another, so that in seedlings over a month old the mycelium had advanced to the cone of the growing point. The mycelium at the beginning is both intracellular and intercellular. In the tip of the growing point it is intercellular, the hyphæ widening at the point of penetration into the host cell. The number of nuclei in the mycelium cells varied from one to many. A long list of papers consulted is appended. A. L. S.

Cytology of Collybia.—WILLY HARNACK ("Die Entstehung des Paarkernmycels bei *Collybia tuberosa* Bull. und *Schizophyllum commune* Fr.," *Zeitschr. Bot.*, 1931, **24**, 353–80, 17 text-figs.). The appearance of the pairing nuclei in the haploid mycelium of *Collybia tuberosa* takes place after the anastomosis of two mycelia of different sexes; all the different cells of the hyphæ similarly mate, and there is formed a diploid mycelium. The actual anastomosis and the formation of the paired nuclei was not seen in *Schizophyllum*, but the subsequent development leaves no doubt that the same process has taken place. If two mycelia with clamp connections are joined, there may be seen in the mixed mycelium hyphæ with many nuclei in the cells, and conjugation can be observed without preliminary clamp formations. These multinuclear cells send out side branches, into which a pair of nuclei always pass, so they also give rise to mycelium with paired nuclei. A reversion to haploid mycelium never takes place. A. L. S.

Nuclear History in Basidiomycetes.—MARGARET MARTIN VOKES ("Nuclear Division and Development of Sterigmata in *Coprinus atramentarius*," *Bot. Gaz.*, 1931, **91**, 194–205, 48 text-figs.). The author has completed our knowledge of nuclear fusion in the basidium and the subsequent formation of sterigmata and spores. There are eight chromosomes in the fusion nucleus. Reduction takes place in the first division, which is minutely described, its migration to the apex of the basidial cell and the formation of four hyaline bodies on the cell wall, with which the nucleus is connected by cytoplasmic threads. These hyaline bodies remain attached to the apex of the cell wall, and are of importance, as the wall pushes up from their position to form the sterigmata. The nucleus moves to these points and there pushes up, the hyaline body always being ahead. After the spores are formed, the basidial cell, containing cytoplasm and large vacuoles, remains rigid and does not break down. A. L. S.

Function of Oidia.—H. J. BRODIE ("The Oidia of *Coprinus lagopus* and their Relation with Insects," *Ann. Bot.*, 1931, **45**, 315–44, 1 pl., 24 text-figs.). Oidia of Basidiomycetes are formed by the breaking up of the mycelium, or at the tips of mycelial branches or oidiophores. The oidiophore frequently excretes a drop of liquid in which the oidia are immersed. Mycelium developed from oidia has thinner hyphæ, grows slowly, and does not form fruit bodies, but it has been proved that insects may transfer oidia from a + mycelium to a − mycelium and *vice versa*, in which case they fuse and the product is a diploid mycelium. The oidia of *Coprinus lagopus* thus resemble the pycniospores of the Uredineæ in being immersed in a fluid attractive to flies and in their transportation from one mycelium to another, thus securing the diploidization of mycelium of basidiosporous origin and of opposite sex. A. L. S.

Abnormality in Russula.—FERNAND and Mme. MOREAU ("Un hymenium supplémentaire sur le pied d'une *Russula*," *Bull. Soc. Mycol., France*, 1930, **46**, 193–4). The writers found a supplementary hymenium on the stalk of *Russula vesca*. There were mixed with the usual cortical hyphæ hair-like elements rich in contents, the cells with two nuclei or a large fused nucleus, these forming a regular hymenium with basidia and cystidia over a considerable portion of the stalk. The authors see in this a homology of the different cells of the carpophore, all possessing the power to become fertile cells. A. L. S.

Note on Russula fusca.—M. JOSSERAND ("Note sur *Russula fusca* Quél. et *R. mustelina* Fr.," *tom. cit.*, 195–8, 1 text-fig.) The author has raised the question as to the position of *Russula fusca*. He found a specimen in the pine woods which he

has described under that name. He finds, however, that the descriptions are so confusing that he is inclined to treat his *Russula* as a variety of *R. integra* or of *R. xerampelina*. A. L. S.

Study of Polyporaceæ.—H. Lohwag ("Zur Ableitung von Polyporaceæ über *Odontia*," *Ann. Mycol.*, 1931, **29**, 87–91, 1 text-fig.). The author dissents from the conclusions arrived at by previous writers as to the origins and the relationships of Hydnaceæ and Polyporaceæ. It had been argued that, as in *Odontia sudans*, hollow spaces occurred in the hymenial projections, therefore the formation of pores could be traced from that genus. Lohwag rejects that view and gives an account of his own conclusions. A. L. S.

Notes on Amanites.—E. J. Gilbert ("Notules sur les amanites," *Bull. Soc. Mycol., France*, 1930, **46**, 157–76). Gilbert has studied the species dealt with in the field. He describes one new species, but his work is mainly concerned with forms and variations of species already described. He deprecates the making of new species without sufficient knowledge of polymorphism, and insists on the necessity of following carefully the development and growth of these variable fungi. A. L. S.

Notes on Amanita pantherina.—Maurice Sauger ("Sur le polymorphisme d'*Amanita pantherina* (De C.) et ses variations de toxicité," *Bull. Soc. Mycol., France*, 1931, **46**, 207–8). Sauger has raised the question of the toxicity of *Amanita pantherina* in view of the many different accounts of poisoning. He comments on the several varieties of the species, and suggests that we may here be dealing, not with varieties, but with different species. A. L. S.

Notes on Amanita aspera.—J. Carina ("L'*Amanita aspera* est inoffensive," *tom. cit.*, 213–14). Again there is raised the question of poisoning. Carina considers the *Amanita* might easily be taken for *A. rubescens*, a favourite article of food. He has been at pains on three occasions to verify its harmlessness in small quantities or even in large. A. L. S.

Mutinus in Europe.—Theo. J. Stomps ("Ueber das Auftreten von *Mutinus elegans* in Europa sowie von *Clathrus Treubii* auf Sumatra," *Ber. Deutsch Bot. Ges.*, 1931, **49**, 52–62, 2 text-figs.). The fungus was found on Isola Madre, in Lake Maggiore, during a botanical excursion. Stomps discusses the finding of other species, which he compares with the above. He suggests the possibility of its introduction to Europe along with other tropical plants. He also relates the discovery of a new locality for a Java fungus, *Clathrella Treubii*, now found in Northern India. A. L. S.

Nidularia.—S. Killermann ("Die *Nidularia* Fr. Gruppe," *Krypt. Forsch.*, 1931, **2**, 194–8, 1 pl.). Killermann gives a review of the whole genus, which he divides into three sections: *Sorosia*, *Scutula* and *Granularia*. He describes in full detail eight European species, already known to science. A. L. S.

Amanita in the Congo.—M. Beeli ("Contribution à l'étude de la flore mycologique du Congo. Fungi Goossensiani VIII," *Bull. Soc. Roy. Belg.*, 1931, **33**, 100–9, 3 pls.). Beeli finds that *Amanita* is well represented on the Congo, and has added many new species to the genus. He also records numbers of species that are intermediary forms and that indicate the trend of evolution. The most common species in that region was *A. annulatovaginata* Beeli, akin to *A. vaginata*, which it seems to have replaced. A. L. S.

Study of Russulæ.—R. SINGER ("Note sur deux variétés nouvelles," *Bull. Soc. Mycol., France*, 1931, **46**, 209–12). Singer has described, at length, varieties of *Russula sphagnophila* and of *R. maculata.* They were both found in woods near to Prague, and have been carefully examined and diagnosed. A. L. S.

Mycological Studies.—RENÉ MAIRE ("Études mycologiques," *tom. cit.*, 215–44, 9 text-figs.). Maire contributes descriptions of many fungi belonging to different groups and families. One of the most interesting is an account of *Anthurus aseroiformis* McAlpine, a species native to South Australia, but, since the war, found several times in Eastern France, near to Raon-l'Etapes (Vosges). It occurred there in 1920 and again in 1926, 1927 and 1928. Other fungi are described from Algeria, Greece, etc., almost all of them new to science. A. L. S.

Outdoor Mushrooms.—ALICK RUSSEL (*Gard. Chron.*, 1931, **89**, 456). The author takes occasion to question the dates suggested as best for laying down outdoor ridges for mushrooms. The best results, he states, are obtained if the beds are laid out from September to March; they are already bearing crops in the early summer months. He gives careful and helpful notes as to the preparation of these beds. A. L. S.

Spanish Fungi.—A. A. PEARSON ("Hongos de Sant Pere de Vilamajor," *Cavanillesia*, 1931, **4**, 20–3). A rather long list is given of Basidiomycetes with two Discomycetes collected in Spain in November, near to the town of Sant Pere de Vilamajor, most of them from a wood of ilex and cork-oak, on sandy or slatey soil. A considerable number are marked as new to Spain. Pearson was assisted in his search by Enrique Gros, from the Museo de Ciencias Naturales of Barcelona. A. L. S.

Bavarian Fungi.—F. PETRAK ("Fungi Adeani. Ein Beitrag zur Pilzflora Bayerns und der angrenzenden Länder," *Krypt. Forsch.*, 1931, **2**, 155–94). Petrak has examined material collected by A. Ade during a number of years. They are microfungi, and were found on decaying leaves, wood, etc. The list includes a large number of new species and two new genera, *Pleurodiscus* and *Pleurosticta*, the latter on living lichens, and both members of the Sphæropsideæ. A. L. S.

Rumanian Fungi.—T. SAVULESCU and C. SANDU-VILLE ("Contribution à la connaissance des micromycetes de Roumanie," *Bull. Soc. Mycol., France*, 1930, **46**, 177–92). The authors here publish a list of microfungi, many of them parasitic. They give habitat and locality. The list is not complete, as families such as Uredineæ, Peronosporaceæ, etc., are still to be published. The present contribution includes 142 species. A. L. S.

New or Rare Fungi.—F. PETRAK ("Mykologische Beiträge zur Flora von Spanien, Portugal und der Insel Madera," *Ann. Mycol.*, 1931, **29**, 107–28). Most of the fungi described were found on dead wood or decaying leaves; a large majority are new species of Pyrenomycetes, etc. A new member of the Sphæropsideæ is described, *Cytodiscula carnea*, n. gen., n. sp. It grew on dead wood, and is considered by the author to be probably a stage form of some Discomycete. A. L. S.

Exotic Fungi.—E. M. WAKEFIELD ("Fungi exotici: XXVII," *Bull. Misc. Inf., Roy. Bot. Gard., Kew*, 1931, 201–6, 4 text-figs.). With the exception of one species, *Merulius miniatus*, the 12 fungi described are minute species from widely distant countries—New Zealand, India, Africa, etc. A. L. S.

Austrian Fungus Flora.—JULIUS TOBISCH ("Beiträge zur Kenntniss der Pilzflora von Kärnten," *Oesterr. Bot. Zeitschr.*, 1931, **80**, 108–35). Tobisch has considerably extended the list of Austrian fungi, and has brought determination and nomenclature up to date. He deals with most of the large families—his numbers run from 907 to 1,248—and has given, not only habitat and locality, but has frequently added descriptive and biological notes when anything unusual has to be chronicled. A. L. S.

Natural History Notes on Fungi.—CECIL P. HURST ("Natural History Notes round Great Bedwyn," *Wilts Archæol. Nat. Hist. Mag.*, 1931, **45**, 279–90). Hurst notes the weather that prevailed in 1929, when the fungi were collected, and its effect on fungus growth. He records a considerable number of the larger fungi, many of them new to the Marlborough region. The rust fungi were collected in large numbers, several of them rare specimens, and their record is accompanied with valuable biological and descriptive notes on habitat and appearance of host and parasite. A. L. S.

Nutrition of Fungi.—J. S. MAHARQUE and R. K. CALFEE ("Effect of Manganese, Copper and Zinc on Growth and Metabolism of *Aspergillus flavus* and *Rhizopus nigricans*," *Bot. Gaz.*, 1931, **91**, 183–93, 7 text-figs.). Fungi absorb mineral nutrients, though they do not possess photosynthetic metabolism. This investigation has proved that cultures of *Aspergillus* made better growth when the minerals were present in the medium in small quantities; larger quantities proved to be toxic. A combination of the three metals was also more favourable than any combination of two. Fat content of the *Aspergillus* was increased by the presence of manganese, copper and zinc, but the nitrogen content was less than in control cultures. A. L. S.

Study of Phymatotrichum.—B. F. DANA ("Soil Cultures for the Laboratory Production of Sclerotia in *Phymatotrichum omnivorum*," *Phytopathology*, 1931, **21**, 350–6, 2 text-figs.). The aim of the research was to discover the conditions in which the sclerotia of the fungus developed most easily. They were thus able to understand the moisture and temperature requirements for the development of this cotton-root rot fungus, *Phymatotrichum omnivorum*, and also to test the best means for dealing with the disease. A. L. S.

Soil Microflora.—ANNELIESE NIELHAMMER (Prag.) ("Über den Einfluss einzelner Beizmittel auf die Bodenmikroflora," *Zeitschr. Pflanzenkr.* (*Pflanzenpath.*) *und Pflanzensch.*, 1931, **41**, 257–66). The writer has considered and experimented on the problem as to interfering with the natural condition of the soil by introducing various chemicals along with the seeds, with the result, presumably, to destroy the microflora that are beneficial as well as those that are harmful (to the seeds). Experiments were made with *Mucor racemosus*, *Bacterium subtilis*, *Actinomyces odorifer*, etc. The content of the different solutions is given, and the result of the applications. *Actinomyces* was the only organism that suffered; all the others, bacteria or fungi, were, on the whole, stimulated. The substances employed were Germisan, Tutan, Ceresan, Upsulun Universal, and Ababit. It was found that these solutions, when sprayed, had also a somewhat favourable effect on the host.
A. L. S.

Toxic Action of Fungi.—C. CAPPELLETTI ("Sull'azione dei prodotti del ricambro di miceli micorizogeni sulle piante ospiti. Ricerche fisiologiche e morfologiche," *Ann. di Bot.*, 1931, **19**, 1–62, 3 pls.). Cappelletti's object in this

research was to examine the direct relation between the mycorrhizal fungus and the host plant—if it were mutually advantageous or the reverse. He has studied the question by cultures, especially of the fungus, and judging its effect when applied to *Allium* spp., the host plants, by introducing the cultured mycelium into the soil. Full accounts are given of the various experiments and their results. He has found that the fungus extract exercises a toxic influence on the host cells, by diminishing transpiration, by causing histological lesions, either in the closely associated tissues or in those at a distance, and also by disturbance in the embryo. A long bibliography is appended. A. L. S.

Action of Poisons on Yeasts.—S. Koslyčev and V. Berg (" L'action des poisons sur la levure vivante, la levure sêche et le jus de macération," *Bull. Acad. Sci. U.S.S.R.*, 1930, **7**, 631–59). Poisons such as thymol, strychnine, cocaine, etc., were used on the yeast cultures, and the results are set out in a long series of tables. In many cases the poison agents act as a growth stimulant, especially on diastatic fermentations. Comparison is made between growing yeasts and dry yeasts, as well as maceration juice, the reaction in these being equal or higher than in the case of growing yeast. A. L. S.

Study of Helicobasidium and Septobasidium.—K. B. Boedjin and A. Steinmann (" Les espèces des genres *Helicobasidium* et *Septobasidium* des Indes néerlandaises," *Bull. Jard. Bot.*, *Buitenzorg*, 1931, **11**, 165–219, 5 pls., 2 col., 31 text-figs.). The species of these genera discussed have been recently collected in the Dutch Indies. *Helicobasidium compactum* Boedj. is the only species of that genus included in this work; it was found parasitic on tea and a few other plants. For *Septobasidium* 18 species are described, 8 of them new to science. The species of this genus are parasites of phanerogams, most of them living on *coccidæ*. In cases where that is not evident, the phanerogam has been found to be a favourite feeding ground for these insects; the fungi are also reported as living on their excreta or in symbiosis with them. The principal fact noted by the writers is that the insects are so altered and destroyed by the fungus that it is impossible to determine them. Descriptions, well illustrated, are given of the various species. Some of them form fairly large patches on the leaves, up to 6 mm. or more in extent. A long list of literature dealing with these fungi is appended, and an index to the species. A. L. S.

Study of Typhula graminum.—Heizi Tasugi (" On the Snow-Rot (Yukigusare) Fungus, *Typhula graminum* Karst., of Graminaceous Plants," *Journ. Imp. Agric. Exp. Stat. Japan*, 1929, **1**, 55–6, 3 pls.). Tasugi has studied the fungus by means of cultures, and describes the complete development: a white mycelium is formed, then in two weeks sclerotia, at first white, then reddish-brown. From the sclerotia rise the hymenophores, simple or branched and clavate. The fungus severely attacks winter wheat, barley, etc., under snow. A. L. S.

Parasitic Fungi.—F. L. Stevens (" Parasitic Fungi of Peru and Ecuador," *Ann. Mycol.*, 1931, **29**, 102–6, 3 text-figs.). Many different genera and species are included in this list; they were collected by the author in 1924. He diagnoses and figures a new Dothideaceous fungus, *Phæophragmocauma Buddleyæ*, the new genus distinguished by its stroma development and by the dark septate spores. Several new species are also described. A. L. S.

Enemies of the Douglas Pine.—Hans Schwarz (" Die Wichtageren Feinde der Douglasii in Nordamerika," *Zeitschr. Pflanzenkr.* (*Pflanzenpath.*) *und Pflanzensch.*, 1931, **41**, 266–8). Schwarz furnishes a useful summary of the more

prominent agents of disease of Douglas pine. He lists eight insects and then passes on to the fungi, of which there are 14 given, with the account of their attack on the tree, whether on stem, leaf, or root. He also adds mistletoe as a parasite.

A. L. S.

Disease of Strawberry.—A. N. BROOKS ("Anthracnose of Strawberry caused by *Colletotrichum Fragariæ* n. sp.," *Phytopathology*, 1931, **21**, 739–44, 3 text-figs.). The disease attacked the runners, causing the death of young plants during the period of plant propagation. It has been observed only in Florida, and is characterized by dark brown to black lesions on the runners ; the leaves were immune unless infection was secured by wounds. The fungus was diagnosed as a new species of *Colletotrichum*. No other stage of the fungus has been found, and no other host than the cultivated strawberry. The term "anthracnose," signifying "leaf-scorch," has been used by the writer to designate the disease. A. L. S.

Study of Cotton Disease.—T. FAHMY ("Étude de la pénétration du champignon *Fusarium vasinfectum* Atk. var. *ægypticum* T. Fahmy," *Bull. Soc. Bot., Genève*, 1931, **22**, 62–125, 28 text-figs.). This disease of cotton was first described, under the term "Wilt," as a parasite of the vessels, and was considered as a wound parasite. Fahmy finds that the parasite attacks the roots at a very early stage. The development of the fungus was followed : in 10 days the region of the root-cap is entirely invaded by the hyphæ, and later the vascular system. Experiments on growth were made with different media, and the results compared. There was noted a preference for nitrate rather than ammonia as a nitrogenous supply. It was also proved that the fungus grew well in the absence of cellulose, starch, or sugar. In the host the fungus lives on the normal noruishment of the host ; it was not considered that it attacked the protoplasm. By its possession of the vessels it chokes circulation, but it is owing to its action on the growing roots that the parasite is so destructive. A. L. S.

Apple-Scab Fungus.—E. S. SALMON and W. M. WARE ("A New Fact in the Life-History of the Apple-Scab Fungus," *Gard. Chron.*, 1931, **89**, 437–8, 3 text-figs.). The fungus (*Venturia inæqualis*) persists through the winter on the fallen diseased leaves and on the young wood ; the infection of the new leafage is thus easily explained. The writers here discovered that the bud scales are also already infected, and so pass on the disease. They impress the necessity of spraying with Bordeaux mixture before blossoming time. A. L. S.

Citrus-Scab Fungus.—ANNA E. JENKINS ("Development of the Citrus-Scab Organism, *Sphaceloma Fawcettii*," *Journ. Agric. Research*, 1931, **42**, 545–58, 5 pls., 1 col.). The paper deals with the growth of citrus-scab on sour orange (*Citrus Aurantium*) and on grape-fruit (*C. grandis*). The characters of the fungus and the development on the hosts were studied in artificial cultures and on the hosts, both leaves and fruits. Secondary fungi, such as *Cladosporium*, were continually associated with scab organisms, and these also have been dealt with. Jenkins has amply proved the pathogenicity of the *Sphaceloma*, even after 11 years of artificial culture. A. L. S.

Lichens.

Study of Leptogium.—M. M. HOLLERBACH ("Notes sur la Morphologie et la Biologie de *Leptogium Issatschenkoi* Elenk. dans les conditions naturelles d'habitation," *Bull. Jard. Bot. Princ. U.R.S.S., Leningrad*, 1930, **29**, 320–2, 2 pls.). Hollerbach has given a careful description of this lichen with the two forms *lobata* and *tuberculata*. He finds in the centre of the lobes a series of hyphæ parallel to

the surface with disorganized *Nostoc* cells. The hyphæ take an upright tangled direction towards each periphery. In normal conditions neither cortex nor rhizinæ are developed, but when the lobes come into contact with other lobes, a cortical layer or rhizinæ are formed. These evidently are due to irritation, and may be formed also by the irritation caused by the mosses among which it grows.

A. L. S.

Lichens of Leuenberg.—Karl Schulz-Korth ("Lichenologische Beobachtungen bei Leuenberg (Oberbarnim)," *Verk. Bot. Ver. Prov. Brandenb.*, 1931, **73**, 90–4). The author gives an account of the lichens observed during an autumn excursion to Leuenberg. Particular attention was given to the atmospheric conditions and to the presence of light or shade. Along with the lichens recorded are various biological notes: thus ammonia-loving forms were more abundant near culture areas; in other places certain lichens had disappeared owing to similar interference with natural conditions, such as the breaking up of rocks and the pollarding of willows. The struggle for place among lichens was observed also: the growth of some species over others characterized as "epiphytism."

A. L. S.

New Lichens.—Bouly de Lesdain ("Notes lichenologiques. N. XXIV," *Bull. Soc. Bot., France*, 1930, **77**, 612–15). A series of new or rare lichens, with biological notes. *Placodium cæspitosum* is normally grey in colour and only becomes yellow in very dry localities exposed to the sun. No fructifications have been found. *Staurothele Meylani* n. sp. grows on calcareous rocks in the Jura; not only the thallus but also the spores are tinted rose colour. A. L. S.

Lichens of Provence.—Jacques Maheu ("Lichens d'Aix-en-Provence, 1926–7," *Bull. Soc. Bot., France*, 1930, **77**, 597–611). The territory explored was in the near neighbourhood of Aix, where were an abundance of calcareous rocks and forests of pines. In all, 91 species are recorded, mostly on calcareous rocks, but a number also on soil or on trees. A. L. S.

New Lichens.—A. Zahlbruckner ("Neue Flechten, X," *Ann. Mycol.*, 1931, **29**, 75–86). The author gives descriptions of many interesting new species or varieties from distant lands, east or west, some from Japan and Malaya, others from various regions of the western continents. From Galapagos he describes two species of *Dirina* that grew on trees. A. L. S.

Isidia of Verrucaria.—E. Bachmann ("Ueber Isidien auf dem Lager einer epilitischen *Verrucaria*," *Ber. Deutsch. Bot. Ges.*, 1931, **49**, 110–14, 3 text-figs.). The lichen *Verrucaria horizontalis* Zschacke grew on calcareous rock in Anhalt. Bachmann describes the growth of the thallus and then the formation of the isidia as very irregular growths from the surface. The isidia are composed of hyphal cells forming a plectenchyma, and the gonidia are abundant. These isidia branch irregularly from stalks, and are liable to be easily separated from the thallus, and thus useful in propagation. A. L. S.

Bavarian Lichens.—J. Hillman ("Beiträge zur Flechtenflora Bayerns 1," *Krypt. Forsch.*, 1931, **2**, 225–39). No reasoned account of Bavarian lichens has been published since Krempelhuber issued his work in 1861. Hillman revises the species already known and has included the many new discoveries made since that date. He follows Zahlbruckner's *Catalogus universalis*, but indicates the species already listed in the 1861 book. A. L. S.

Cladonia.—HEINRICH SANDSTEDE ("Die Flechten Deutschlands, Oesterr. und der Schweiz. Die Gattung *Cladonia*," *Rabenh. Krypt. Flora*, Abt. iv, **2**, 1931, 1–240; 241–531, 8 text-figs., 34 pls.). In the introduction to this treatise Sandstede gives a general account of the habitats most favoured by *Cladonia*, a universal genus of lichens. He then notes the influence of different types of substratum on the development, so that there arises, in similar circumstances, a similarity between different species forms often difficult to determine. The influence of wind and light is emphasized and, therewith, the changes that follow the cutting down trees and so letting in light, entailing different forms and colouring, the disappearance of shelter from the wind giving rise to other erratic forms. The microscope, he points out, is of little value in determination of *Cladoniæ*; there is but little difference in spore production. Sandstede questions the advantage of giving varietal and form names to plants that owe the change of form more or less entirely to differences in habitat or exposure; he inclines to think that there is an advantage, however, in the definition gained by distinct naming, or even raising to specific rank, a practice he has frequently followed. A careful account is given of structure of the twofold thallus, and also of the fructification. *Cladoniæ* develop spermogonia and carpogonia, and in some instances trichogynes are present. In certain species the apothecia develop as asexual bodies, so Sandstede concludes that in the genus can be traced a development from the sexual to the parthenogenetic condition. The genus is treated under three subgenera: *Cladina*, *Pycnothelia*, and *Cenomyce*. Keys to all the species are given, and full accounts, with synonymy, biological notes, etc. A. L. S.

American Cladoniæ.—C. A. ROBBINS ("Cladonias collected by S. F. Blake in the Western United States," *Rhodora*, 1931, **33**, 135–9, 1 pl.). The lichens were studied and determined by C. A. Robbins before his death in January, 1930. The results have now been prepared and published. There is a list of 27 specimens, one species, *C. Blakei*, new to science, somewhat *pyxidata*-like, but distinctly yellow. A. L. S.

Japanese Lichens.—Y. ASAHINA ("Materials for a Lichen Flora of Japan," *The Saito Gratitude Foundation, Sendai, Japan*, 1931, 1–94, 23 pls., 1 map). Asahina laments the lack of information concerning Japanese lichens, which has induced him to produce descriptions of species and specimens to make at least a beginning of a Japanese lichen flora. Many of the specimens are fully described in English and Japanese, without final determination. In all, 73 forms are listed, beginning with *Verrucaria*; thus five *Verrucariæ* are described, but only one, *V. fuscula*, determined. All of them are figured on the plates. This is only the first instalment of the work. A. L. S.

Umbilicariaceæ.—EDUARD FREY ("Weitere Beiträge zur Kenntniss der Umbilicariaceæ," *Hedwigia*, 1931, **71**, 94–119, 8 text-figs.). In this paper Frey continues the study of the family Umbilicariaceæ. He has come to the conclusion that the genus *Umbilicaria* should also include *Gyrophora*. He gives his reasons for this decision. He has, however, divided the genus into three subgenera: (1) *Lasallia*—thallus with pustules and asci with 1–2 muriform spores; (2) *Gyrophoropsis*—thallus without pustules, asci with 8 septate or muriform spores; (3) *Gyrophora*—spores 1-celled, hyaline. The last subgenus is divided into several sections with differing thalline characters. *Umbilicaria pustulata*, in this scheme, belongs to the subgenus *Lasallia*. A very full study has been made of the thalline anatomy, as well as of the apothecial characters. A. L. S.

Chiodecton sanguineum.—F. Tobler ("Der Fall des *Chiodecton sanguineum* (Sw.) Wainio. Ein Beitrag zur Stoffwechselphysiologie der Flechten," *Ber. Deutsch. Bot. Gesellsch.*, 1931, **49**, 158–66, 4 text-figs.). Tobler discusses the question as to the systematic position of the plant known as *Chiodecton sanguineum*. His research has, however, enabled him to justify its inclusion among lichens. He has examined abundant material, and he finds that while at the circumference of the thallus there are fungal hyphæ only, at the centre algal constituents are present, generally *Trentepohlia*, but also frequently cystococcoid or blue-green forms in smaller quantities. He has concluded that the true gonidium is *Trentepohlia*, as the fungus unites more closely with it. As a result of symbiosis, the plant forms the acid "Chiodecton," a crystalline, rose-coloured substance that shares with other lichen acids the capacity to dye material. This colouring matter is formed mostly at a distance from the algal formation, and at the circumference mainly, though also in the central portions, as red "isidia," which are purely fungal pustules; but acid formation is nevertheless dependent, he finds, on the symbiotic union of the two constituents, testifying to the physiological equilibrium between the alga and the fungus. He points out also that it is in thalli where the union with *Trentepohlia* is most closely developed that the production of the acid is most abundant, the alga being thus essential to the formation of the red crystals. Along with these there is a great production of oxalate crystals, which also are lacking in the central portion. Tobler suggests or concludes that these crystals serve as nourishment for the alga, as a source of carbonic acid gas. There is discussed, also, the apothecial formation recorded by Nylander but still somewhat uncertain.

A. L. S.

Study of Lecanoræ.—A. H. Magnusson ("New or Otherwise Interesting *Lecanora* Species," *Göteborg Bot. Trädgård*, 1930, **6**, 1–20). Magnusson has found that many species, such as *Lecanora cinerea* and *L. gibbosa*, are collective species insufficiently defined. Most of the species dealt with belong to the section *Aspicilia*, and are mainly northern in distribution. A. L. S.

Study of Lecideæ.—A. H. Magnusson ("Studien über einige Arten der *Lecidea armeniaca* und *elata*-Gruppe," *tom. cit.*, 93–144). An exhaustive study of a somewhat obscure group of species of world-wide distribution. A key to the species is included. A number of species have been reduced to varieties or forms; thus, under *L. elata*, nine varieties or forms are described, several of these new to science.

A. L. S.

Isidiose Lichens.—V. Gyelnik ("Notes on *Peltigera*," *The Bryologist*, 1931, **34**, 16–19). Gyelnik describes two new species, one from New England, *P. Evansiana*, and one from Chili, *P. chilensis*. Both are isidiose forms and are contrasted with nearly allied species, the former with *P. lepidophora*, the latter with *P. microphylla*. Gyelnik has added a key to all isidiose species so far known.

A. L. S.

Study of Lichen Substrata.—V. Gyelnik ("Lichenologische Substratstudien (*Squamaria radiosa* Gruppe)," *Hedwigia*, 1931, **71**, 120–32). *Lecanora radiosa* (*L. subimbricata* or *L. circinata*) grows on rocks and walls, etc. Gyelnik has studied both the chemical nature of the substratum, giving three different groupings, and the morphological characters, giving five groupings. He adheres to the name *Squamaria*, rather than to *Placodium*, to indicate the thalline form. In this study he has examined many specimens in the Hungarian National Museum, testing, by chemical reactions, not only the lichens, but the substratum. The latter may be either calcareous or siliceous. After using these different criteria, Gyelnik lists seven

species, five of them new to science or, rather, new "appreciations." He retains the name *Squamaria radiosa* for a species which inhabits a mainly calcareous substratum, with the reaction of the thallus K + yellow, then red. In some of these new species there is no reaction, in others only the medulla is affected. A. L. S.

Spore Germination in Lichens.—ROGER-GUY WERNER ("Etude comparative de la germination des spores de lichens," *Bull. Soc. Mycol., France*, 1930, **46**, 199–206, 1 pl.). Werner gives an account of the different types of spore germination in lichens. He begins with unicellular spores such as those of *Parmeliæ*, *Usneæ*, *Cladoniæ*, *Lecanoræ*, etc. In every case he finds that the spore in these lichens emits more than one germinating tube—generally from each extremity. An exception was found in *Pertusariæ*, which have very large and multinucleate spores; they emit a large number of germinating tubes all over the surface through small swellings of the endospore. Bicellular spores, as in *Ramalinæ*, *Physciæ*, etc., produce tubes from each cell. Special attention was given to the polarilocular spores of *Xanthoriæ*, etc.; they germinate with one or two tubes at the extremities. In *Anaptychia* there was formed a primary mycelium from the spore composed of short, almost round filaments, later developing to a secondary normal mycelium, strands of which pierced the substratum as rhizinæ. A. L. S.

Mycetozoa.

Studies of Mycetozoa.—E. JAHN ("Myxomycetenstudien. 13. Die Stielbildung bei den Sporangien der Gattung *Comatricha*," *Ber. Deutsch. Bot. Ges.*, 1931, **49**, 77–82, 1 pl.). Jahn here describes the progressive formation of the sporangial stalks in *Comatricha*, each phase being illustrated by photographs; first of all a minute clear drop, which extends upwards, within which the darker strands of the stalk are visible. Gradually the sporangium elongates and the plasma gathers to the top. The point of the stalk is for some time visible within the head. In this genus the stalk is not hollow, but is composed of strands due to the thickening and development of the membranes. A. L. S.

Ecology of Myxomycetes.—ERNEST C. SMITH ("Ecological Observations on Colorado Myxomycetes," *Torreya*, 1931, 42–4). Smith has reported on the conditions favourable to growth of mycetozoa in a region of mountain and plain. The best localities were in mountain valleys with restricted seasonal rains, an available supply of water through a definite period being necessary. Where there is much dryness, the mycetozoa may occur on decayed logs and get their moisture from dead or living trees affected by heart-rot. Rapid evaporation leads to arrested development and distortion of form, and also to attacks by moulds at various stages of development. The most favourable situation was found to be at an altitude 8,000 to 9,000 feet, where moisture was abundant from springs, beaver-dams, etc. A. L. S.

Java Mycetozoa.—YOSHIKADZU EMOTO ("Javanische Myxomyceten," *Bull. Jard. Bot., Buitenzorg*, 1931, **11**, 161–4). Emoto tells of his sojourn in Java as a delegate from Japan to the Pacific Scientific Congress, held in Java, May, 1929. During his visit he examined the territory for mycetozoa, and he also gives results of an exploration of Krakatoa, from which only one species, *Physarum cinereum*, had been reported in 1897. Owing to the dry weather on the island, only 11 species were found. From Java he secured 44 species, many of them from the Buitenzorg Botanical Garden. Three species were added by him to the Javanese list, which now numbers 95 species. The author gives locality and habitat for his specimens. A. L. S.

Myxobacteria of Poland.—HELENA I SEWERYN KRZEMIENIEWSCY ("Miksobakterje Polski Część trzecia," *Acta Soc. Bot. Pol.*, 1931, **7**, 250–73, 3 pls., Polish with German summary). In this third contribution the author has added 12 species new to Poland, 6 of which are new to science. The species for Poland now number 41. Full descriptions of the new species are given—three species of *Polyangium* and three species of *Chondromyces*. A. L. S.

NOTICES OF NEW BOOKS.

Microscope Record.—No. 23. May, 1931. 24 pp., 12 text-figs. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

Technical Instrument Bulletin.—Vol. 3, No. 4. June, 1931. 16 pp., 16 figs. Published gratis by the Emil Busch Optical Co., Ltd., Diamond House, Hatton Garden, E.C. 1.

Faune de France.—Vol. 22, Part 2. Mollusques terrestres et fluviatiles.—By LOUIS GERMAIN. 1931. vi+419 pp., 13 plates, 390 text-figs. Published by Paul Lechevalier, 12, Rue de Tournon, Paris (VI^{e}). Price 150 fr.

Life by the Sea-shore. An Introduction to Natural History.—By MARION NEWBIGIN, D.Sc. Re-written and revised by Richard Elmhirst. 1931. 296 pp., 20 plates. Published by George Allen & Unwin, Ltd., 40, Museum Street, London, W.C. 1. Price 7*s.* 6*d.* net.

Recent Advances in Microscopy: Biological Applications.—Edited by A. PINEY, M.D., M.R.C.P. 1931. vii+260 pp., 83 illustrations. Published by J. and A. Churchill, 40, Gloucester Place, Portman Square, London, W. 1. Price 12*s.* 6*d.* net.

The paths of editors are not strewn with roses, and the task of the editor of this, the latest addition to the "Recent Advances" series, is one which no one will envy him, for the difficulties of deciding what to include and still more what to exclude must have been great indeed. The book consists of four somewhat unequal parts. The first 30 pages, written by the editor, are devoted to a brief and somewhat unsatisfactory account of the present position of certain aspects of human histology. No references are given in this chapter, which is definitely not intended for the professional histologist, though without a considerable previous knowledge of histology it is doubtful whether its perusal would convey much useful information. The next 57 pages are filled by a masterly account of the microscopy of the living eye, written by Mr. Basil Graves. So much may now be seen of the living eye by the use of slit-lamp microscopy that, as the writer remarks, many pictorial living processes such as pupil contraction, the circulation of the blood cells in the vessels, their inflammatory exudation and deposit, as well as many other features, might well be made a subject for demonstration in the curriculum of all medical students. The next 80 pages are taken up by an account of recent advances in the cytology of animal cells, admirably written by Professor MacBride and H. R. Hewer. Mitochondria, spermatogenesis and oogenesis, the nucleus and the nucleolus are some of the subjects dealt with, though most space is devoted to a consideration of the extensive and somewhat acrimonious literature which

deals with the Golgi apparatus and the vacuome of Parat. The account of pathological cytology is, frankly, disappointing. No mention is made of any of the recent work on virus inclusions. Botanical cytology is dealt with in the last 84 pages by E. C. Barton-Wright. Here, again, the Golgi apparatus receives much attention, together with such subjects as polyploidy, meiosis and sex-chromosomes. Chambers's work on micro-dissection is rather briefly discussed. Taken as a whole, this book should appeal to all those who are interested in microscopy as applied to the different branches of biology. G. M. F.

Mikrobiologie und Immunitätslehre.—Ein Leitfaden für Studierende und Ärzte. By Dr. H. Hetsch. 1931. viii+443 pp. Published by Urban & Schwarzenberg, Berlin and Vienna. Price RM. 15.

This book, intended for students and medical practitioners, gives a useful summary of our present knowledge of microbiology as applied to medicine. In just under 450 pages an account is given of bacteriology, both general and special, bacteriological technique, staining, immunology, protozoology and filterable viruses. The treatment is of necessity brief, but to anyone who reads German fluently and wishes to obtain a summarized knowledge of medical microbiology the book can be unreservedly recommended. G. M. F.

The Regulation of Size as Illustrated in Unicellular Organisms.—By Edward F. Adolph, Ph.D. 1931. x+238 pp., 66 figs., 15 tables. Published by Bailliere, Tindall & Cox, 7 and 8, Henrietta Street, Covent Garden, London, W.C. 2. Price 20*s*.

One of the fundamental problems which has always exercised the imagination of biologists is the size of organisms. While the fertilized germ cells of the eel and the elephant, for instance, are not dissimilar in size, their capacities for growth are very different. In the case of multicellular organisms the multiplicity of the factors regulating size is obviously so great as to preclude any possibility of deducing any general laws from the data available. In unicellular organisms, however, there is greater possibility of direct experimental observation throwing light on the factors involved. Biparental inheritance, at least, is avoided, though size in itself is in no way an explanation of unicellular structure, for while a large unicellular organism such as Spirostomum has 4×10 times as much substance in its body as a Pseudomonas, the body of the average man has only 5×10 times the volume of a Spiristomum. There is, therefore, as much diversity in size among unicellular organisms as there is between unicellular and any other group of organisms. In the present monograph the author has collected, in a comprehensive fashion, the information at present available on the factors involved in regulating size in unicellular organisms. The rate of growth, the variation in body size under standard conditions and the inheritance of size are some of the more important subjects discussed. Whilst there is a relationship between the size of the nucleus and that of the cytoplasm, much more evidence is required before it can be definitely asserted that the size of the nucleus controls the size of the cytoplasm. The only conclusion that can at present be drawn is that every factor so far investigated is found to modify body size in some species or another of unicellular organism. There is an excellent bibliography. G. M. F.

// JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER, 1931.

TRANSACTIONS OF THE SOCIETY.

XVI.—ON THE STRUCTURE AND DIVISION OF THE SOMATIC CHROMOSOMES IN NARCISSUS.*

By SYED HEDAYETULLAH, M.Sc., Ph.D. (Lond.), F.L.S., F.R.M.S. (State Scholar, Government of Bengal). **576.312**

(*Read December* 16, 1931.)

FIVE PLATES.

INTRODUCTION.

WITH the increasing amount of support which the genetical study of both plant and animal material is receiving from the chromosome theory of heredity, the detailed cytological history of the chromosome has been attracting considerable interest from every student of biology. Moreover, in view of the theoretical conception of the distribution of the genes within the chromosome and their interchange as the possible explanation of the differential character found in the offspring of a cross (Morgan, 1928), a thorough knowledge of the constituent materials of the chromosome, its structure, and the time and manner of its division during the different stages of mitosis and meiosis, must be considered essential in order to secure a true cytological foundation for the chromosome theory of heredity.

In the study of the chromosome cycle in mitosis, three main points, viz., origin, structure and division of chromosomes, have been the subjects

* Thesis approved for the degree of Doctor of Philosophy in the University of London.

of discussion and controversy; the solution of the problems involved has yet to be definitely found.

The present study has been undertaken to clarify, as far as possible, the above three points in the mitotic phenomena of a particular plant. Before entering into the description of the observations made, it will be advisable to state briefly the nature of the problems as they stand at present.

The Nature of the Problems.

1. Regarding the origin of the chromosome, it is well known that the so-called autonomous and individualized chromosomes found at the equatorial plate do not exist as such during the whole cycle of the mitotic division; their immediate origin is from thread-like chromatic bands found in prophase. These, again, originate from a structure variously described—from a reticular network to a tangle of granular threads of the resting stage. The structure of the nucleus of the resting stage originates, in turn, from the telophasic transformation of the autonomous, fully formed and individualized chromosomes, which, after their separation during anaphase, group at the two poles of the spindle. So, in tracing the origin of the definitive chromosomes, one finds that two processes are continually going on in the mitotic phenomena—one is the evolution of chromosomes and the other the resolution of the same. The materials which are concerned with these processes lie in the nucleus of the resting or metabolic stage from which chromosomes derive their origin, and to which again they are transformed. The structure of the nucleus at the metabolic or resting stage, variously described by numerous authors working both on fixed and living material, may be classified into three groups—homogeneous, granular, and reticular. This matter will be discussed later. Whatever may be the true structure of the resting nucleus, the chromosome-forming material is there; the so-called karyotin of the resting nucleus, which represents the chromosomes at that stage, may be only in a diffused state, and in the course of mitosis it is transformed into chromosomes. The nature and composition of this karyotin may be conveniently discussed in connection with the structure of chromosomes. The present status of the problem of the origin of chromosomes is as follows. Admitting that the material which forms the reticulum of the resting stage is identical throughout the cycle of evolution of chromosomes, it is because of the changes in the state and form of the material in different stages of mitosis that we see a different form and structure of chromosomes.

2. The problem of the structure of chromosomes is greatly involved and intimately related with the question of their origin. We have seen that the karyotin of the resting nucleus is the chromosome-forming material, but whether this karyotin is a true chemical compound or a loose combination of two or more constituents has not yet been finally decided. Owing to its varying staining capacity in fixed material at the different stages of mitosis, the karyotin has been further distinguished as linin and chromatin, and the chromatin, again, as oxychromatin and basichromatin, according to its affinity for the acidic or basic dyes. But this conception of the classification of the chromosome-forming material has been disputed (Sharp, 1926) on the ground that the changes in staining reaction are correlated with the changes in the physical state of the chromatin. So at present oxychromatin and basichromatin are regarded as two functional states of one substance.

A similar interpretation has been applied to the relation between chromatin and linin. Whatever may be the physico-chemical relationship of the chromosome-forming material, one point has been observed by all investigators, namely, that at some phase the morphological dual constituents of chromosomes can be discerned with great clarity. These constituents have been variously named according to the manner of their occurrence and construction in chromosomes; the less chromatic element has been known as "achromatic matrix," ground substance or substratum, and the chromatic element as chromomeres (when in the form of granules) and chromonema (when it is a thread), often more or less spiral.

According to the chromomere conception of chromosome structure, chromosomes are made up of a row of granules in an achromatic or less chromatic substratum. This conception was first originated by Pfitzner (1882), and is still held by Sands (1923, 1925), Belling (1926, 1928*a*, *b*, 1931). Bolles-Lee (1924), on the other hand, strongly criticized the existence of chromomeres, remarking that they were due to faulty interpretation of "twists and bulges" of chromatic threads. Vejdovsky (1912, 1927), working both on animal and plant material, asserts that chromomeres have real morphological existence, and derive their origin from the chromatic element of chromosomes during telophasic and interphasic transformation; he further points out that these chromomeres join together to form filiform spiral chromatic threads, to which he first applied the name

"chromonema." It may be said here that one or two chromonemata have been described by different authors as constituting the structure of chromosomes with achromatic matrix at least at certain stages of mitosis.

The alveolar structure of the chromosome was first suggested by Van Beneden, and later worked up into a vigorous theory by Grégoire and his school (1903, 1906). At first it was thought that fully formed chromosomes are homogeneous, and that the alveolization or vacuolization is introduced later in the telophase. At that stage, in each chromosome, a row of vacuoles was seen shining through the darkly staining chromatic substance. In 1906 Grégoire distinguished two substances forming the chromosomes—an achromatic one forming "la traume," and a chromatic one, "porté par la traume." Strasburger (1905), Müller (1912), and Sharp (1914, 1926) admitted the possibility of an alveolar structure of chromosomes. Lately Overton (1922) and Bolles-Lee (1920) traced an alveolar structure in late prophase, metaphase, and anaphase. The last mentioned author has been so confident of the alveolar structure of chromosomes that he distinguished plant chromosomes from animal chromosomes owing to the presence of alveoles in the former and their absence in the latter. Overton, like Grégoire, distinguishes two substances constituting the chromosome—the ground substance and the "colony of discrete bodies" or granules on it, and says that the alveolization takes place in the less dense ground substance. Apart from structural importance, the phenomenon of alveolization has been long considered to have a great significance in the mechanism of the splitting of chromosomes.

3. The whole result of mitosis is the division of chromosomes into two equivalent portions for the reorganization of two daughter nuclei. Around this phenomenon of chromosome division, otherwise known as longitudinal split of the chromosomes, centre all the important events of mitosis; consequently, much attention has been paid to this question by numerous cytologists. The problem has been considered from two angles, viz., the time, i.e., at what stage, and the manner, i.e., the mechanism by which the splitting of the chromosomes takes place.

Flemming in 1880 showed first that the chromosomes of the equatorial plate are double, i.e., composed of two similar halves. The parallelism and close proximity of the halves of the metaphase chromosomes suggested that they arise by longitudinal splitting of previously undivided mother chromosomes. To settle this point, cytologists first enquired at what stage chromosomes are first seen to be double. The result of this enquiry is that the origin of the split or doubleness has been traced in almost every stage of mitosis—metaphase, anaphase, telophase and prophase—by different authors.

The way in which chromosomes divide has been still more difficult to explain, since different complicated types of chromosome structure are involved, viz., chromomeric, chromonematic or spiral (single spiral or two spirals), and alveolar. Whether the simple longitudinal split along the length of the chromosomes is applicable to chromosomes of all the types of structure has been a moot question in connection with the phenomenon of mitosis. Accordingly, various other processes have been suggested in conformity with the respective structure of chromosomes. Martens (1922) has suggested the bipartition of a chromonematic thread along the two margins of the chromosomes. The endogenetic origin of double chromosomes has been put forward by Bonnevie (1908, 1911). Kaufman (1926) thinks that the origin of the chromonemata from each half-chromosome (chromonema) is by a process of "internal organization" in the chromomeres. The theory of simple longitudinal split may be applied without much difficulty where chromosomes are supposed to be composed of rows of chromomeres, the split initiating either in chromomeres (Strasburger, 1905) or in the achromatic space first (Müller, 1912). The same is true when the chromosome is of alveolar structure by the centralization of the alveoles along the longitudinal axis of the chromosome when its longitudinal splitting may take place (Grégoire, 1906).

Bolles-Lee (1920), working on *Paris quadrifolia*, has asserted that during mitosis the doubling of chromosomes is brought about by transverse segmentation at the apex of the V-shaped chromosomes during the telophase. His observations and views have been strongly criticized by Martens (1922), who worked on the same material.

Material and Method.

Bulbs of the garden variety "Chinese sacred lily," procured from Messrs. Sutton & Sons, were first used for the collection of root apices. These, on preliminary count of the chromosomes, were found to be a tetraploid variety containing $4n = 28$ chromosomes. For a comparative study, bulbs of diploid species, *Narcissus pseudonarcissus*, also were obtained by the kind courtesy of Prof. Th. J. Stomps, of Amsterdam.

Some of the bulbs were grown in clean moist sand in pots and some in Knop's culture solution in the greenhouse of King's College. It was found that the root-tips fixed from the bulbs grown in moist sand show ample dividing nuclei, whereas the root-tips from the bulbs grown in the culture solution show very few.

Nine different fixatives were tried—Flemming, both strong and weaker, Benda, chromacetic acid solution, Hermann, Merkel, Bouin, Allen's modification of Bouin, La Cour's fluid and Navashin's fluid. The formulæ of the mixtures were those given by Chamberlain (1928) and Sharp (1914). The formula of La Cour's fixative was secured from *Nature* (27th July, 1929), and that of Navashin's from Maeda's paper (1930).

Fixation.—Root-tips grown ¼ inch long were cut in the fixing fluid at different hours of the day. Root-tips fixed from 9 to 12 a.m. showed innumerable dividing nuclei. After collecting the material in the fixing fluids, the air of the bottle was pumped out by an exhaust pump to secure rapid killing and fixation of the material.

Of the fixatives employed, strong Flemming and Merkel's gave the best results. Bouin's and Hermann's were also good, but the former tended to swell the chromosomes and obscure their internal structure, while the latter had the effect of contracting the chromosomes to such an extent that they became very much narrower and slender, and their split was often obscured. Another objectionable effect of Hermann's fluid is that it renders the cytoplasm coarse and dense. Benda's fixative, which has been so highly approved by many authors, did not work satisfactorily with the present material. With this fixative the chromosomes had a swollen appearance and lost their sharpness of configuration.

Materials were fixed in different fixatives for varying lengths of time extending from three to fourteen hours, and particular care was taken to secure thorough washing.

The long method of dehydration was followed by two or three final changes in absolute ethyl alcohol. Both xylol and cedar-wood oil were employed as clearing agents. The clearing in xylol was done in the same series of grades of xylol and alcohol as that of dehydration grades. Paraffin wax of 52° melting-point was employed throughout, but in order to get thin sections, wax of 60° melting-point was also used. Microtome sections were cut of various thicknesses, ranging from 3μ to 30μ according to the object of the study.

Staining.—It has been a problem to investigators of chromosome structure to secure an ideal stained preparation which should reveal all the details of structure, due to the fact that the constituent materials—chromatic and less chromatic—have different staining capacities at different stages of the division. Efforts have been made by various cytologists to overcome this obstacle to the study of chromosome structure. Two methods have been employed.

The first method is to subject the material to some special procedure during killing and fixing. The idea of such treatment is based on the colloidal nature of chromosome constituents and their solubility, digestion, or coagulation in different conditions and agents, thus bringing about by special treatment an increased degree of difference in the chromaticity between the two constituents of the chromosomes.

The second method is the special technique employed in staining the sections to bring out the suitable differentiation between the chromatic and less chromatic constituents of chromosomes. In the difficulty of obtaining such differentiation lies most of the uncertainty regarding the minute structure of chromosomes of late prophase, metaphase, and anaphase, as both the constituents at these stages have almost the same condensation, and consequently similar chromaticity. When a section is stained by the long method, the constituents of chromosomes, being of almost similar condensation, retain similar stain even after proper destaining, because they were over-saturated with the deposition of stain, being kept for a long time in the stain. Again, the long time taken in destaining the sections with iron-alum solution causes a general muddy appearance of the cytoplasm, obscuring clear visibility under the high-power microscope.

Kaufman (1926) first realized that the short method, which consists of mordanting for two hours in 2½ per cent. iron-alum and staining for the same period in ½ per cent. solution of hæmatoxylin, gives better differentiation of the two constituents. There can be little doubt that by following this method he obtained results which differed from those of Sharp (1920). Sharp (1929), revising his work on chromosome structure, employed the short method and obtained results similar to those of Kaufman, not only in the same material, but also in several other materials.

In the preparations for the present study, the short method of Kaufman was used, with still further modification by reducing the time for mordanting to one hour and staining for the same period in ½ per cent. hæmatoxylin, or mordanting for two hours and staining in ¼ per cent. hæmatoxylin solution.

Although the above method gave desirable results, yet, owing to the comparatively long time taken in preparing a slide, other shorter stains were also tried, such as chromotrope and eosin, and Newton's iodine gentian-violet. The latter stain was extensively used, due to the transparent effect it produces in chromosomes, and also because, when properly destained in clove oil, the less chromatic matrix of the chromosomes becomes almost colourless, thus rendering the chromatic element more prominent and easier to study. It seems to us that this stain is very suitable for staining chromomeres and chromonemata.

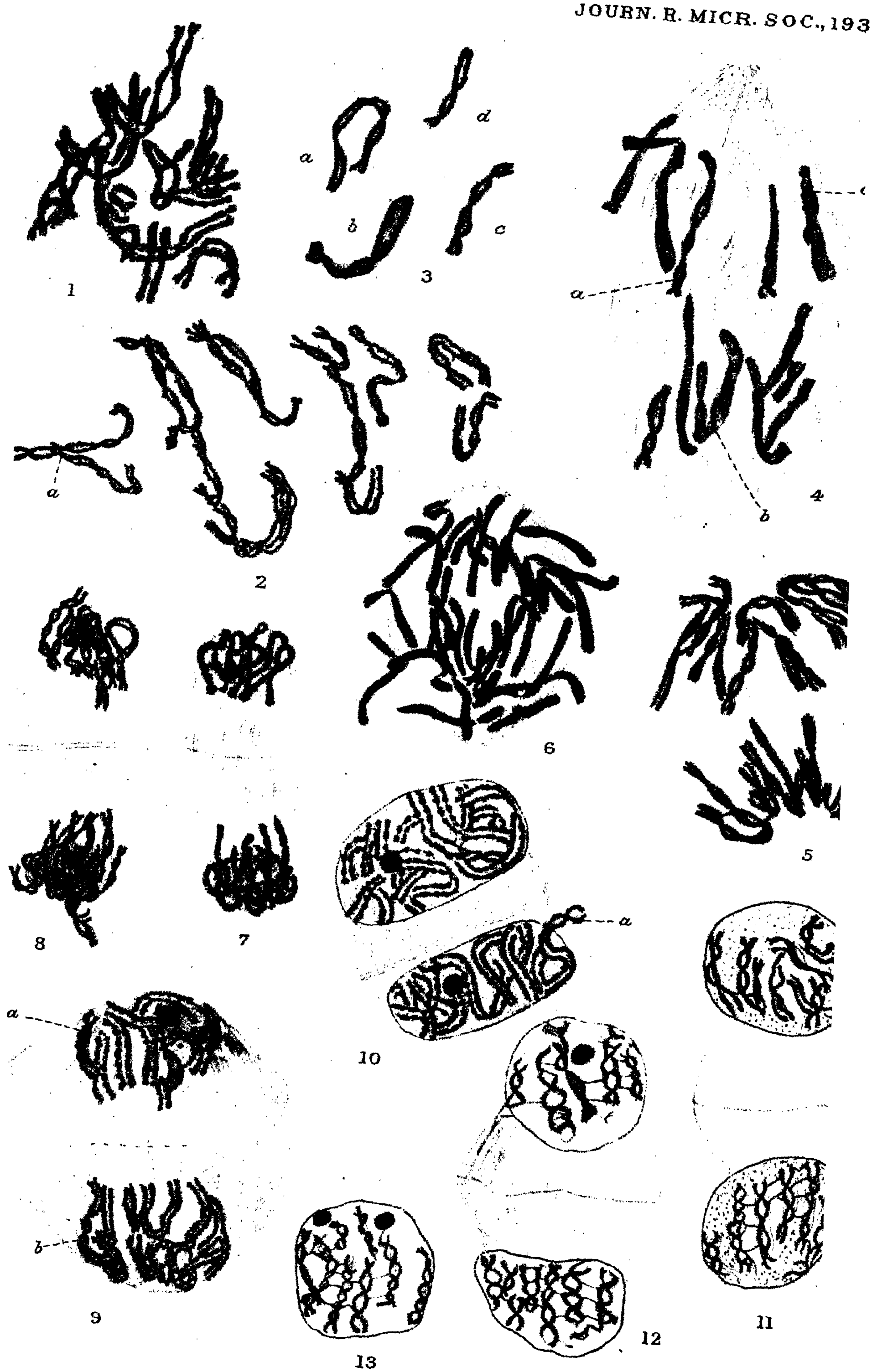
Particular attention was paid to secure proper illumination (Belling, 1930) of the object. Pointolite was used, focusing by a corrected bull's-eye the source of light in the iris of the condenser, and then focusing the bull's-eye on the slide by the condenser. Yellow-green light filters were used as screens.

Description.

Anaphase.—It is convenient to start from the anaphase of mitosis in a detailed study of chromosome structure, because of the fact that at this stage the chromosomes have a truly individualized and independent existence before beginning to participate in the formation of new nuclei. At the

beginning of anaphase the chromosomes have the shape of an inverted J, I, or V, according to the position of the attachment constriction—subterminal, terminal or median respectively—and persist to the later period of this stage (figs. 1–6). The structure of the chromosomes at this stage has been variously described, mostly as uniformly stained and homogeneous bodies differentiating no internal structure, neither alveoles (Grégoire, 1906 ; Fraser and Snell, 1911) nor chromatic spiral nor chromonemata (Martens, 1922 ; Vejdovsky, 1927). But many have seen either alveoles (Overton, 1922) or chromatic spiral (chromonemata) (Bonnevie, 1908 ; Sakamura, 1914 ; Kuwada, 1926 ; Kaufman, 1926 ; and Sharp, 1929). In the present case the anaphase chromosomes, when stained by the short method as described, show two distinctly chromatic filiform threads (chromonemata) running along the length of the chromosomes, intertwining and interlacing with each other in a less chromatic matrix which forms the ground substance of the chromosomes. It can be realized, by careful study of the anaphasic chromosomes of the figures, that the degree of intertwining of the two chromonemata of each chromosome is not always the same. In some chromosomes, figs. 2 (marked *a*), 3 (marked *a* and *b*), 4 (marked *a*), there are four or five points where the two intertwining chromonemata have crossed each other ; in some the number of crossing points may be three, two, or even one, figs. 2, 3 (marked *d*) and some of the chromosomes in fig. 5. The interspace between crossing points has different shape and size according to the distance between two successive crossing points—diamond to globular where the crossing points are close together, and linear or more or less elongated where the crossing points are at long intervals. These diamond or globular regions in the achromatic matrix may sometimes give the appearance of vacuoles within the chromosomes, the chromatic element forming the border of the vacuoles ; in fact, they are not vacuoles within the body of chromosomes, but spaces between two intertwining chromonemata bounded by them and their crossing points. This fact can be very well realized by observing the chromosomes steadily under the microscope and at the same time slowly manipulating the micrometer screw. In the first place it is seen that at the crossing points one chromonema is superposed on the other, the upper one seen at higher focus and the lower one at lower focus ; in the second place the length of the chromonemata can be followed throughout the whole length of the chromosomes in most cases, and at the free ends of the chromosomes two ends of the chromonemata can be clearly seen (figs. 2–5).

In some cases, instead of intertwining with each other, the two chromonemata run more or less parallel, coiling round the matrix (fig. 4, marked *b*). Here it becomes a little difficult to establish that not one but two chromonemata are present, unless one finds two free ends at the extremities of the chromosomes. In fig. 4 the two chromosomes lying immediately left of the chromosome marked *b* each show at their lower ends free ends of the two chromonemata. It should be remarked here that when materials are fixed in Merkel's fluid and stained with iodine gentian-violet, the chromonemata



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of the chromosomes at this stage show a more or less granular or chromomeric appearance (figs. 2, 3), but as the anaphase proceeds, they become more and more uniformly stained, and the chromomeric appearance of the chromonemata is gradually obscured. In most cases in the late anaphase, when the chromosomes clump together at the poles, they stain very deeply, due to a strong chromaticity at this stage; consequently, the chromonemata become indistinguishable from the matrix, but one sees a nodular and moniliform appearance of the chromosome—the narrower regions representing the crossing point and the wider region representing the interspaces bounded by the chromonemata. Even at this stage, at least in some of the chromosomes, one can see the intertwining aspect of the chromonemata (fig. 7). Fig. 8, which is of a similar stage, but stained with iodine gentian-violet, shows them very clearly. It may therefore be said that though due to the effect of either fixation or stain, it is sometimes obscured from observation, yet in suitable preparations the dual structure of the chromosomes remains perfectly distinguishable.

There is another hindrance to the conspicuous view of the chromonemata structure of the chromosome: this is when in the optical field the chromosomes are not seen in their flat position, but in side view. In this position one only sees the optical section of the chromonemata showing arch-like discontinuous chromatic elements along the length of the chromosomes (fig. 4, marked *c*); but these arch-like chromatic elements show a regular disposition in opposite orientation, which represents only the two continuous intertwining chromonemata seen under optical section, and hence the discontinuous appearance. From the above description it can be seen that the anaphasic chromosomes of both diploid and tetraploid Narcissus are composed of two chromonemata more or less intertwined with each other in a less chromatic matrix. The nature of this matrix is best seen at the interspaces of crossing points of the chromonemata.

At the commencement of the description of the anaphasic chromosomes it has been remarked that most of the investigators have described the chromosomes at this stage to be a homogeneous single structure; but there are authors who have described the anaphasic chromosomes to be double as a result of longitudinal split taking place at this stage. Merriman (1904) was the first investigator to describe the anaphasic chromosomes as double owing to the longitudinal split in them. Bonnevie (1908, 1911), in Ascaris and Allium, reported the origin of two spirally coiled chromatic threads from the anaphasic chromosomes. Lundegårdh (1910, 1912*a*) considered the axial vacuolation of the anaphasic chromosomes of Allium and Vicia as a true split, while Němec (1910) and Sakamura (1914) see the same central vacuolation of an anaphasic chromosome, but place no such interpretation on it, and do not regard it as a longitudinal splitting of the chromosomes. But Granier and Boule (1911) and Lundegårdh (1912*a*) held the view that longitudinal splitting occurs in the chromosomes during anaphase, and the latter author further asserts that the anaphasic split is quite as evident and distinct as the split in the prophase. Sarbadhikari (1927), in describing the chromosomes at the very late anaphase, saw " a light line running along the centre of some of the chromosomes " which he regards as showing the " vestige of split."

Kaufman (1926), Sharp (1929), and Telezynsky (1930) saw, as in the present case, chromosomes of the anaphase composed of two intertwining chromonemata.

From the above historical references it is quite clear that all the above-mentioned investigators have observed the doubleness of the chromosomes at the anaphase. By the former group of authors the doubleness has been regarded as due to the longitudinal split of an already existing single chromosome. The latter group of authors hold that the

doubleness of the chromosomes at this stage is not due to the close association of sister chromosomes after the longitudinal split into two of a mother chromosome, but that it is the construction of an individual mother chromosome to be composed of two chromonemata intertwined with each other. Whether this doubleness is a split of a chromosome or a duality of chromosome structure can be understood after considering other stages of the mitosis.

Bolles-Lee (1924) has described doubleness in the chromosomes of *Paris quadrifolia* at the late anaphase and polar clump stages, but he considered that the doubleness was due to longitudinal superposition of the limbs of the V-shaped chromosomes in the process of their infolding during those stages. His views of the duplicity will be discussed later.

Telophase.—It has been generally observed that the telophase is preceded by a stage where the chromosomes, at the end of the anaphase, clump together, forming a more or less deeply-staining chromatic mass. This stage was first described by Grégoire, and he gave it the name "tassement polaire." Overton (1922) regards it as a fixation artefact found only in preparations which are considered to be poorly fixed. He finds that material fixed with Merkel's fluid does not show this clumping of chromosomes at this stage. In the present preparation of the material fixed in Merkel's fluid, "tassement polaire" is a quite common feature, although the clumping is not to such a great extent as to obscure the individuality of the chromosomes, but the chromaticity is too strong to reveal any internal structure of the chromosomes. With the beginning of the telophase, the chromosomes, having been much shortened and thickened during the stress of the polar clumping, show the tendency to relaxation which is manifested by their separation from one another (figs. 9–14, 16, 17).

It should be mentioned here that a remarkable difference of behaviour is found in the structure of the chromosomes between the material fixed with Merkel's and other fixatives like strong Flemming and Hermann's. In the former case the chromonemata of the chromosomes give a distinctly chromomeric appearance, and they generally lie parallel (figs. 9, 10) and show no interchromosomal connection by fine more or less chromatic threads, such as are supposed to bring about anastomosis of the nuclear reticulum. But in some cases the chromonemata show one or two twists round each other (fig. 9, marked *a* and *b*; fig. 10, marked *a*). In the latter case the chromonemata are uniformly chromatic throughout their length at the earlier stage of the telophase, and are intertwined with each other more loosely than they were at the anaphase, and show at many places interchromosomal connections by fine slightly stained threads (figs. 11, 12, 13, 14, 19). We have seen that these interchromosomal connections—which have been described by many authors—between the telophasic chromosomes could not be found in the preparation fixed in Merkel's fluid, whereas they are clearly seen in other preparations. It may be said here that this phenomenon of anastomosis between chromosomes or chromatic threads has been a quite general feature, not only in telophase, but also in earlier prophases as observed by many investigators. Consequently, various interpretations have been put on the significance of their presence. Boveri (1904), Gates (1912), Lundegårdh (1912*b*), Von Schustow (1913), and Sarbadhikari (1927) explain them as a form of pseudopodia from the body of the chromosomes, ultimately

inosculating with each other, the result being the lateral anastomosis of the chromosomes. Grégoire and his students, on the other hand, describe them as the adhering portions of chromosomes once pressed closely together. This explanation seems to us more reasonable, since we have seen the chromosomes were once clumped together at the end of the anaphase ("tassement polaire"), and then gradual separation took place at the beginning of the telophase; consequently, there is every possibility of retaining the adhering connections, the substance of the chromosomes being viscous in nature. But if the condition of the "tassement polaire" is regarded as fixation artefect, then "they are outgrowths of highly active, mobile chromatic threads," as Kaufman thinks may be a proper interpretation of the phenomenon. In examining the structure of chromosomes under living conditions, Telezynsky (1930) describes the presence of these lateral anastomoses both in the telophase and in the prophase. From this fact, and, in the present case, from their presence when fixed with certain fixatives and their absence in others, it is suggested that their occurrence may be natural, but that they disappear under the action of some fixatives having a solvent influence on the particular structure.

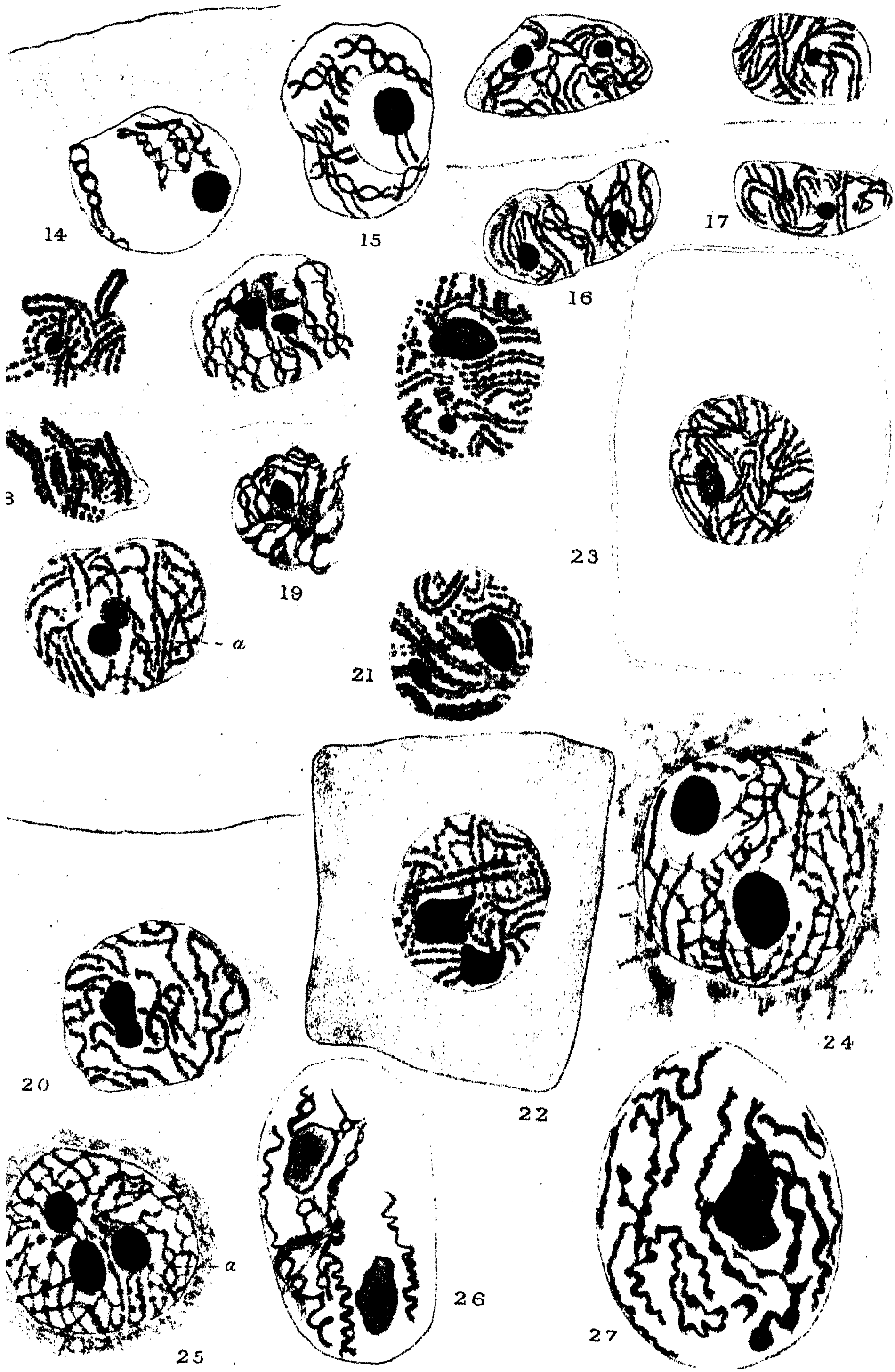
The less chromatic matrix still occupies the interspaces of the twining chromonemata, which become still less chromatic than they were at the anaphase. This can be realized by comparing figs. 3 and 4 with figs. 11–14. It should be mentioned here that the lateral anastomoses are always between the chromonemata of two adjacent chromosomes in the region between the crossing points, and show a comparatively broader appearance of the interspaces, probably due to the effect of the anastomosing connections in pulling them apart. Figs. 11–14 show very clearly the stretching effect on the chromonemata at the points where the lateral anastomoses occur.

In the cases (figs. 9, 10, 17, 18) where the two chromonemata, instead of being intertwined, are lying more or less parallel, and the chromonemata show a granular appearance, it can be seen in some cases that the two adjacent granules of a chromosome are connected by a fine short chromatic bridge (fig. 9). Sometimes they are in close touch with each other, forming paired granules (figs. 9, 10).

It has been a common experience to describe a vacuolar structure of the chromosomes at the telophase, vacuolation taking place along the central axis of the chromosomes and so giving rise to their alveolar structure. In the present material at this stage where the chromonemata are intertwined, the regions between the crossing points being broader than the region where the chromonemata cross each other, and the interspace at this region between the chromonemata being achromatic, due to the gradual disappearance of the less chromatic matrix, this figure gives us, at first sight, an appearance resembling that of so many vacuoles within the chromonemata. But we have satisfied ourselves, by very careful study, that these are not vacuoles within the chromosomes, but only spaces between two intertwining chromonemata. This can be realized by considering the following facts: (*a*) the

presence of two free ends at the extremities of the chromosomes, representing the ends of the two chromonemata ; (*b*) at the narrow regions which have already been described as the crossing points, by manipulating the micrometer screw one can see the two chromatic threads crossing one over the other at one point and then diverging for a little distance, and then again converging and crossing at the next node (fig. 11) ; (*c*) in some chromosomes the chromonemata of which show less frequent intertwining, instead of diamond- or globular-shaped interspaces we see a lighter region between the two parallel chromonemata (fig. 11, in some of the chromosomes at the upper pole, and figs. 16, 17). One peculiar behaviour of the chromonemata is noticed in our study of the telophase stage—they show both intertwining and parallel disposition with each other in the same daughter-nucleus at the same stage (figs. 11, 16, 17), but towards the end of the telophase, when the nucleus is passing into interphase, the parallel association becomes, as a rule, general. In rare cases they may show one or two twists in some chromosomes (fig. 20, marked *a*). From this it may be inferred that in earlier stages of the telophase the two chromonemata forming a chromosome may remain intertwined, but towards the end of the telophase they untwine and consequently become arranged parallel (figs. 15, 18, 20). It is also noticed that as soon as the chromonemata become disposed parallel, the chromatic granules make their appearance along the length of each chromonema, with lighter spaces between the granules, thus giving the appearance of a beaded structure of the chromosome (figs. 17, 18). This matter will be discussed later.

It has been shown above that the structure of the telophasic chromosomes is not vacuolar, but composed of two chromonemata—the intertwined condition of which may sometimes easily deceive an observer who is prepossessed by the idea of vacuolization as the cause of the split (Lundegårdh, Von Schustow, Fraser and Snell, and Digby). On the other hand, in reality, as has been explained, the seemingly vacuolar appearance is the result of intertwining of the two already existing constituents of the chromosome. Hence the duality of the telophasic chromosomes in Narcissus cannot be regarded as the outcome of a split at that stage by the process of vacuolation ; neither is it " optical outlines of the linin sheath, staining dark with iron hæmatoxylin," as Vedjovsky (1927) would have us believe. How can one explain the intertwined duality as the optical outlines of the linin sheath ? The parallel duality may be explained away as the optical outlines, but the intertwined duality cannot be interpreted in the same way because the two sides of a sheath would be always parallel. Bolles-Lee's (1924) explanation of the dual structure of the telophasic chromosomes as " the longitudinally collocated moities of each chromosome twisted round one another " cannot hold here on three grounds : (1) all the chromosomes in Narcissus are not V-shaped, so in the case of I- and J-shaped chromosomes there is no chance of folding over of one arm on the other, followed by twisting round one another, yet the duality is seen in them (fig. 10) ; (2) in each arm of the



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V-shaped chromosomes the duality is already recognized before their arms are collocated (figs. 9, 10, 16, 17) ; (3) is the more important fact—that one can see the duality in all the chromosomes from the very beginning of anaphase (figs. 1–6).

The nuclear membrane appears just after the polar clumping (tassement polaire), when the chromosomes tend to separate from one another. In certain cases, when some portion of the chromosomes project out of the general mass, the nuclear membrane fails to appear there, and a portion of the chromosomes seems to project out of the nuclear membrane (figs. 10, 17, 18, 19). But from the observation of later stages it has been ascertained that complete formation of the nuclear membrane is noticed as soon as the inclusion of the projecting portion of the chromosome within the newly forming daughter-nucleus takes place (figs. 12–14).

The reappearance of one or two nucleoli is almost simultaneous with the formation of the nuclear membrane. When they are first seen, they are generally smaller in size and close to the periphery of the nucleus (figs. 10, 12, 13, 16), and with the progress of telophase, as a rule, they migrate to the more central region of the nucleus (figs. 15, 19, 20). In exceptional cases, however, as in fig. 14, the nucleolus has grown large and more chromatic, but still retains its peripheral position. It is remarkable that the origin of the nucleolus is simultaneous with two other phenomena of the telophasic transformation, viz., the formation of the nuclear membrane and the gradual disappearance of the matrix of the chromosome.

The end of the telophase is approached by the formation of a cell plate along the equator of the spindle, while the unravelling of the intertwining of the chromonemata proceeds till they have become parallel. When the complete transformation of the telophase has taken place, one can see scarcely any intertwining of the chromonemata (fig. 20). The end of the telophase merges with the interphase and the resting stage.

Interphase and Resting Stage.—The term "interphase" was first used by Lundegårdh (1912*a*) to denote the stage between the telophase and the beginning of the prophase for the next division in a rapidly dividing tissue. It is a common experience to notice in it two types of nuclei in which the beginning of prophase has not yet taken place. These two types of nuclei can be differentiated from each other by the following characteristic appearance—in one, the complete transformation of the chromosomes into long spiral or granular threads does not take place. The chromosomes in this case seem to retain their individuality, except that the chromomeric appearance of the chromonema becomes prominently visible (figs. 21, 22, 31). When such is the appearance of a nucleus before the beginning of the prophase, it is known as the interphase stage of the nucleus. In the other, which is generally known as the resting stage, chromosomes as such could no more be distinguishable, but the complete transformation of them takes place either in the form of a network or long granular threads forming an entangled mass. In the present material we

see both these types of nuclei. At the interphase the chromonemata become parallel to each other and show chromomeric structure (figs. 21, 22), and as the interphase passes on to the next prophase, the elongation of the chromosomes occurs to give rise to the chromosomic bands of the prophase.

In the nucleus where complete resting stage has taken place, the transformation of the chromosomes becomes so complete that they lose all the definitive structure characteristic of fully formed chromosomes, and give rise to a structure very difficult to describe and still more difficult to interpret. In the present preparations the resting nucleus gives the impression that it is full of a mass of small particles of chromatic granules, but careful and steady observation reveals that these granules are strung into long threads, and the whole nucleus is filled up with a tangle of these granular chromomeric threads. Again, to each one of these chromomeric threads there is a corresponding one running parallel. This aspect of the resting nucleus could better be seen under the microscope than represented in a figure, because of the fact that the nucleus being comparatively large, from 12 to 14μ in diameter, and the whole of it being filled with such a tangle of long and much-looped threads, it is almost impossible to represent all of them in a drawing in every different level of their position. Even if this is done, too many overlapping threads would obscure the parallel association of threads which it is desired to show. In order to simplify the matter, and at the same time to demonstrate the actual existence of parallelism of the threads at this stage, the following device is adopted. In certain focal levels at the margin of the nucleus the ends of two threads are seen to lie close together. In drawing the figure with the aid of a camera-lucida, we have first marked these ends and followed them as far as practicable by manipulating the micrometer screw, and wherever some other threads are seen to be superimposed on the thread already drawn, we omitted them from the drawing, to prevent the obscuration of the parallel association of the threads. Consequently, figs. 24 and 25 show only a partial number of these granular threads, but we have convinced ourselves, by minute observation, that these granular threads are always double, running closely parallel to each other. In fig. 25 at *a* two threads are seen loosely intertwining at two points. This may be a case of persistency of the telophasic intertwining condition of the chromonemata. It has already been described, in connection with the telophase, that two chromonemata of each chromosome unravel and become granular; and in the resting stage that which we have so long described as the parallel granular threads are nothing but the chromonemata stretched out and lengthened and become chromomeric. These threads also show lateral connections with each other (figs. 24, 25), mostly with the adjacent granules, by a slightly stained fine fibrillar structure. Sometimes they stain similarly to the threads and become as broad. It then becomes very difficult to distinguish them from the chromatic threads, and, due to this effect, the structure of the nucleus at this stage has been commonly described as a reticular or spongy network. Of course, if in a tangle of

granular threads there be again lateral connections between threads at the points of the granules, there is no doubt that the ultimate structure of the nucleus should be a network (fig. 25).

Whether this network is natural or an artefact resulting from fixation has been a question for enquiry in the living material. There, too, one finds three opinions regarding the result of living observation of the nature of the structure of the resting nucleus, as already mentioned. Martens (1927), in interpreting the observations of all the authors who have so far described the structure of the resting nucleus in living material, classifies them into two groups—optimists and sceptics. The former group of authors hold the reticular structure after fixation to be relatively true to natural structure of the living nucleus at that stage, and that if the nucleus is homogeneous and optically empty when observed in the living condition, then it is due to the identical refractive index of the material of the reticulum and the nucleoplasm. The latter group of authors, on the other hand, maintain that the resting nucleus is homogeneous and optically empty. They consider that in the resting stage the colloidal behaviour of the chromosome materials renders the real nature of the structure obscure, as a result of its responding to the change in the physico-chemical condition of the nucleus, viz., sol at the resting stage transforms into gel during mitosis (Lepeschkin, 1923; Fauré-Fremiet, 1928; Schaede, 1926; Yamaha, 1926).

Telezynsky (1930), however, working on living material, describes the cavity of the nucleus as filled up with parallel rows of granules, and thinks that the granules are only optical sections of the thin spiral filaments. In our description we have seen that the two chromonemata of a chromosome during telophasic transformation become granular along their length, thus giving the appearance of chromomeric threads; and in the resting stage this process continues further in thinning and breaking down the granules into still smaller granules—chromioles.

The underlying mechanism of the above process is not known yet under the present conditions, but it may be suggested that, since the volume of the nucleus at the resting stage is comparatively greater than that of the telophase nucleus, consequently some growth of the nucleus is taking place during the metabolic stage, which is again accentuated with the beginning of prophase. If growth is taking place at the metabolic stage, then the increase in the volume of the cavity of the nucleus is also affected. This increase in volume may produce a stretching effect on the contents of the cavity of the nucleus, which we have seen are a tangle of threads more or less granular, and the expansion may also affect the threads and bring about their stretching out too, all being in organic connection with one another in the nuclear cavity, especially all the outer threads being attached to the nuclear membrane.

Now, considering the chromosome material to be of colloidal nature and in the sol condition in the resting nucleus, one can show, by a simple experiment, that a little stretching force may bring about a granular and beaded appearance of once uniform colloidal threads. Thus, if a drop of saliva is taken on the tip of a finger, and then with the thumb a contact is made, and after the contact the fingers are drawn apart slowly, stopping when a thread of about half an inch is drawn, soon along the length of the thread a row of droplets appears. But how far one could be able to correlate this phenomenon with that of the chromonema becoming chromomeric by the process of granulation is yet questionable, though it is plausible that a colloidal thread under little expansion may become a string of droplets, and this after fixation give the appearance of granular threads. From this it appears that the granular threads of the resting stage may be composed of one chromatic substance, the granules being due only to different concentration and condensation along the length of the chromatic thread. The substance of the lateral anastomoses is that which was once the less chromatic matrix of the anaphasic and telophasic chromosomes.

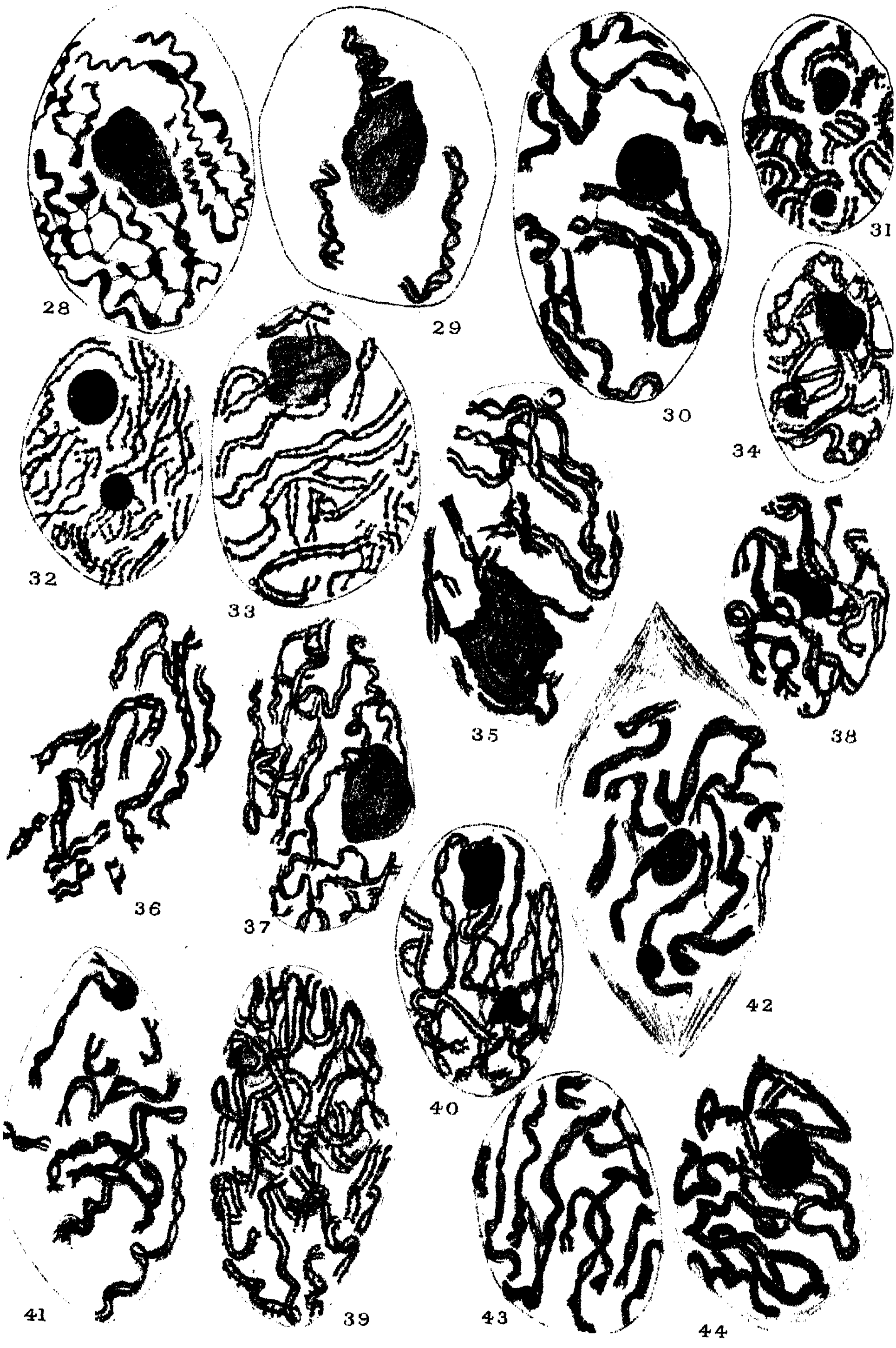
At the resting stage the nucleus contains one to three nucleoli, always spherical in shape and taking deep stain; in some cases there appears a halo or empty clear space round the nucleoli (fig. 24), but in other cases nucleoli are lying just in contact with the tangled mass of granular threads (figs. 21, 23, 25). The nucleolus is usually described as approximately spherical in the resting plant nucleus, and the clear space around it is commonly shown in published papers. This has been regarded by many as an artefact —the result of shrinkage (Frew and Bowen, 1929). Lundegårdh (1912*c*) states that in living cells such a space is very seldom observed. In the present case both conditions are found in the same preparation, though the

former case is more frequent than the latter, and shows also a regular gradation from a very narrow zone to a large zone. This shows that it must be due to fixation, the result depending upon how rapid was the penetration of the fluid in the nucleus. Lundegårdh (1912*c*) also assumed the spherical form of the resting nucleolus to indicate a very fluid consistency.

Prophase.—The beginning of prophase from the resting nucleus is indicated by two characteristic phenomena in the behaviour of the dividing nucleus in the present material:—(1) the nucleolus, which was spherical and regular, becomes irregular in shape (figs. 22, 23, 26); (2) the chromatic threads are closely approximated and more or less definitely orientated around the periphery of the nucleus (figs. 23, 26, 32, 33). We may mention here the most striking variation noticed in the structure of chromatic bands at this stage due to fixation difference. Figs. 26, 27 and 28, 32 and 33 are respectively of the same stage of prophase, but in figs. 26, 27, 28, the chromatic threads are uniformly stained, show spiral coiling and anastomosis to a certain extent between neighbouring threads. The dual association of the threads is scarcely discernible in these figures, though at certain regions along the length of the bands one could see traces of two chromatic threads in close approximation (fig. 26, and in several threads in figs. 27 and 28 of the chromosomic bands near the nucleoli).

These three figures were drawn from material fixed in strong Flemming, whereas figs. 32 and 33, which were drawn from the material fixed in Merkel's fluid, show a quite different type of apparent structure. In the first place, the chromosome threads are not uniformly stained, but show granular or beaded structure, and, secondly, the approximation of the double threads has not proceeded to such an extent as to obscure the duality of the chromosomic bands at this stage; and the anastomoses between neighbouring chromosomic bands are not at all prominent. Moreover, the spiral coiling of the chromosomic bands, which is so dominant a feature of figs. 26, 27 and 28, is quite absent in figs. 32 and 33. From this comparison it is quite reasonable to suppose that the fixation by strong Flemming's has the influence of producing the shrinkage both in the longitudinal and transverse direction, thus bringing about both their spiral coiling and close approximation. Although this shrinkage in the spireme obscures the double association of the chromatic threads from our view, yet in suitably destained preparations, as in fig. 29, one can see clearly that each chromosome band is composed of two coiling and interlaced chromatic threads supported on a less chromatic matrix.

This stage in mitosis has been very critical, and on the real nature of the spireme at this stage depends the most important aspect of the nuclear division, namely, the division of the chromosomes. Those authors who hold the view of telophasic and anaphasic division of chromosomes as already mentioned consider the spiremes to be double; on the other hand, those who maintain splitting to take place either in the late prophase or in the metaphase consider the spiremes to be single. Now, if the association of the double spiremes is not close enough, then each might be mistaken for a



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single spireme. Again, if they are too close, so as to obscure their identity, then, too, they might be regarded as a single spireme. One can realize very clearly how this sort of mistake is possible if the chromosomic bands are like that of fig. 28. The solution of this difficulty lies in determining the number of spiremes present at this stage. In the diploid Narcissus we were able to count the spiremes at this stage, and found 14 double spiremes (fig. 31), which agrees with the $2n = 14$ chromosomes of the plant. In the tetraploid, the chromosome number being as high as 28, the number of spiremes could not be determined so accurately as in the diploid. However, when it could be counted, it is approximately 28 pairs of spiremes. Thus one recognizes a considerable number of parallel spiremes, which might be taken for double bands if one had not studied their origin. But considering their origin as has already been described, they represent the two chromonemata of each chromosome in more or less spireme form in close association with each other, either interlacing and intertwining (fig. 29) or more or less parallel, with one or two half twists along their length (fig. 33), sometimes very close, almost touching one another, and sometimes considerably apart.

This condition is soon followed by the condensation of the chromosomic bands. At this stage the double nature of each band is unmistakably recognized, and shows more general parallel association (figs. 30, 34, 35), though in some of the bands the intertwining aspect is still retained. The granular appearance of each chromatic thread is not so prominently shown as in the earlier stage, and here each thread appears to be more or less homogeneous, but careful observation reveals the chromomeric concentration on the whole length of the thread, which is more darkly stained than the neighbouring region. The space between two threads becomes filled up with the matrix, which also seems to take slight stain, in contrast with the general nucleoplasm. Interchromosomal connection or anastomosis disappears; traces of one or two could be seen here and there (fig. 30). Along the length of the double threads one could see chromatic bridges connecting two adjacent chromomeres. When such connections (figs. 30, 36), which we take to be the result of inosculation between closely placed chromosomes, are present successively in the form of a row, they would be likely to give the appearance of a row of vacuoles within a chromosome band. That they are not true vacuoles within the chromosomic bands can be easily realized by their absence from the same band when the chromomeres are not close enough to allow any contact. It could also be noticed from the fact that, in places where bands are seen to give a complete twist or a half twist, the doubleness is very clearly recognized, one thread being superposed on the other at the point of twist (fig. 36).

In this connection it should be pointed out that the chromosomic bands of this stage sometimes, especially when there are connecting bridges between the chromosomes, give the appearance of the stage which Martens (1922) describes as chromatic bipartition and reconstitution of the chromonematic elements. But we have seen that their earlier history shows nothing to

correlate this appearance with that of Martens' description. He traces the origin of the chromonematic threads at this stage from the junction of a number of earlier discontinuous chromonematic elements of various size and shape lying on the matrix of the chromosomic bands. In our description of earlier stages we have seen that the origin of the chromatic threads was not by the union of chromonematic fragments, but it was the continuation of the process by which two chromonemata of each chromosome became lengthened out and chromomeric.

In the next progressive development of the prophase, all those bridges of chromomere inosculation are seen to vanish, most probably due to untwining coupled with pulling apart of the pairing chromonemata, because at this stage, as can be realized from figs. 34, 38, 39 and 44, both the processes—uncoiling and separation—are gradually occurring in the chromosomic bands, ultimately producing the almost parallel association of the chromonemata of each chromosomic band. If any one of the chromosomic bands is followed (figs. 38, 39 and 44), it will be found that each component thread of a band is maintaining the same course and direction with its sister components—that is to say, that each chromosomic band is perfectly double and the components are parallel.

Further shortening and thickening of the chromosomic threads proceeds, and at the same time some intertwining of the double chromatic threads follows (figs. 40–43); but in the same nucleus one can notice all grades of association of the chromatic threads, from almost parallel to close intertwining. The characteristic granular appearance of the threads of earlier stages vanishes gradually, and they become uniformly stained. The less chromatic matrix tends to increase its affinity for the stain, thus rendering the chromosomic bands more or less homogeneous, with intertwining chromonemata (fig. 43).

The nucleoli, which were of large size and irregular outline in the earlier stage, have become much reduced in size and paler in stain (figs. 41–43). The nuclear membrane soon disappears. Its disappearance is followed by a tendency of clumping together of the chromosomic threads, which by this time have further shortened and thickened, and the appearance of the polar caps of the spindle (fig. 45), with the inception of the chromatic figure. This clumping may be due to contraction of the nucleus at this stage, which seems to be very usual both in mitosis and meiosis (Sharp, 1925). In some cases the remnants of nucleoli persist for a longer time (fig. 42). The shortening and thickening processes proceed till each chromosomic band becomes a fully formed chromosome (figs. 46, 47), thus culminating the prophase stage and passing into the next stage of mitosis, viz., the metaphase.

Metaphase.—This stage is of comparatively longer duration; the fully formed chromosomes are seen at the beginning of metaphase to be floating in the central region of the spindle, having not yet taken their place on the equatorial plate (fig. 46). Each chromosome is double, being constituted of two chromonemata. In some cases doubleness is obscured, due to very

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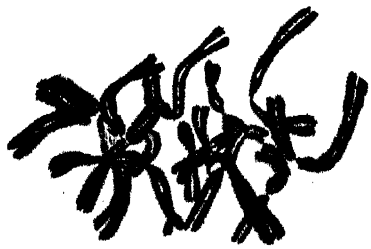

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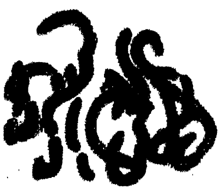

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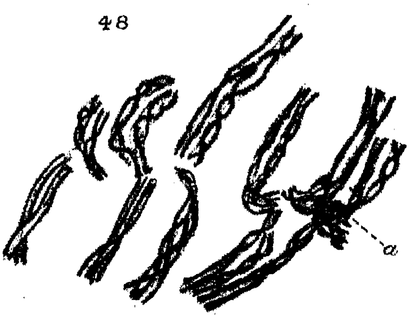

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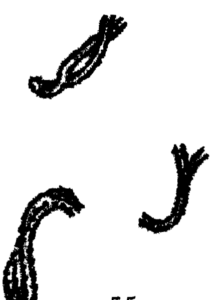

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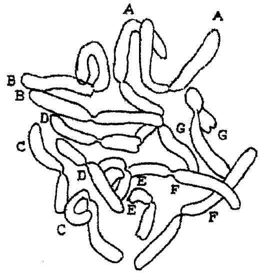

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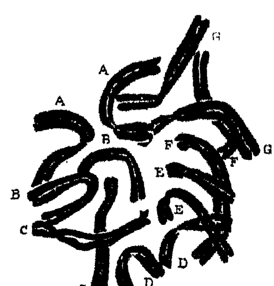

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close approximation and deep staining reaction at this stage (fig. 47). The nucleoli completely disappear. The strong chromaticity of the chromosomes at this stage might be due to the deposition of nucleolar material on the chromosomes. With the disappearance of the nuclear membrane the chromosomes loosen out as an irregular group (figs. 45–48), and fine longitudinal fibrils begin to appear in the hyaline nuclear substance to form the achromatic spindle-fibre. Both the types of pointed and broad pole spindle are found in the present material (figs. 42, 46, 48). While the spindle is taking its proper form, the chromosomes become arranged with a certain portion of each of them lying on the equatorial plate of the spindle (fig. 48). There, as can be seen from the figure, doubleness of the chromosomes is almost lost. They become strongly homogeneous and uniformly stained. Soon the chromosomes are found to be arranged on the equatorial plate slightly spaced out or scattered, and with this arrangement of the chromosomes their doubleness reappears with all the various types of attachment constriction (fig. 49). It is frequently stated, in the description of mitosis, that the chromosomes split during metaphase, after they have become arranged on the equatorial plate as described above. There is no doubt that, in almost every case of mitosis, the split or doubleness of the chromosomes is perfectly seen at this stage, which is just before the dicentric movement of the chromosomes begins. This is the most critical stage of the chromosome cycle, when the period of their association terminates and their dissociation begins. Whatever may be the force which has been so long sufficient to bind them together, it either disappears or changes into an opposite force; consequently, the association between the components of the chromosomes relaxes, and their perfect isolation from each other is the inevitable result.

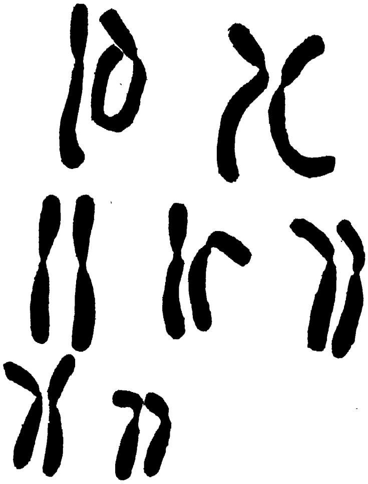
From the history of the chromosome development in Narcissus we know that each fully formed chromosome is the result of condensation, shortening and thickening and, lastly, parallel association of two chromonemata, which have undergone various transformations during the preceding stages, as has been described above. Now, when all the doubly constituted chromosomes, the components of which have a more or less flat ribbon-like shape, have arranged themselves on the equatorial plate, quickly a longitudinal cleavage appears in each component of the chromosomes (figs. 50, 51), thus resulting in a quadruple structure of the metaphasic chromosomes on the equatorial plate. As soon as the cleavage appears, the resulting halves twist round each other, so it may be possible that cleavage of the chromonemata and their intertwining are more or less simultaneous phenomena. In fig. 51 all grades of intertwining between the daughter chromonemata could be seen, from almost parallel cleavage to close intertwining. It should be remarked here that this quadruple structure of the metaphasic equatorial plate chromosomes could be clearly seen from slides stained with iodine gentian-violet (figs. 50, 51). Fig. 52, which is of a similar stage, but stained with iron-alum hæmatoxylin, shows less clearly the quadruple structure of the chromosomes. In the lower portion of the two chromosomes hanging below in fig. 52 is

shown very clearly the intertwining of the two daughter chromonemata in each sister chromosome; this is also shown in the chromosome on the extreme right of the same figure. The intertwining between the daughter chromonemata is seen to vary in different chromosomes. Fig. 54 shows some extreme degree of intertwining, giving the chromosomes an appearance of lattice work. At the end of each sister chromosome two free ends of the chromatic threads could be seen, either lying side by side or like a fork (figs. 50, 51, 54).

The less chromatic matrix occupies all the spaces between the two chromatic threads of the sister chromosomes, thus giving the full structure of the chromosomes to be separated in the anaphase. The quadruple structure of the chromosomes on the equatorial plate is further shown from their transverse section (fig. 53), where it is clearly seen that each section is composed of four isolated chromatic dots embedded in a less chromatic ground substance which again is bi-parted, so that it represents the section of two chromosomes, each consisting of two chromonemata with a matrix of its own. Another very convincing proof of the quadruple structure of the chromosomes at this stage is when the tips of some of the chromosomes are seen in an optical transverse section. In this view one can see definitely four separate darkly stained points comprising the tip of a chromosome (fig. 51, marked *a*). In this case the proximal end of the particular chromosome is slightly tilted up out of the plane of the equatorial plate.

Even when the chromosomes have been arranged on the equatorial plate, the two sister chromosomes are not, as a rule, free from one another, so as to be ready to separate for the anaphase, but they show all degrees of association, from perfectly parallel to two or three twists about each other (figs. 50–55). As the separation of the chromosomes takes place for the anaphase, the first sign of dissociation is seen, as a rule, in the region of the spindle fibre attachment, i.e., at the proximal end of the chromosomes, but in some cases the separation may begin also at the distal end (figs. 2, 50, 55). With the beginning of the separation of the chromosomes we pass to the anaphase, from which stage we commenced our description. It can be seen very clearly that each chromosome, at the time of its separation, is structurally composed of two more or less intertwined chromatic threads (chromonemata) and a less chromatic matrix to support them. It should be recalled here that material fixed with Merkel's fluid already shows the chromomeric appearance in the chromonemata of each chromosome (fig. 55).

On the equatorial plate of metaphase in the transverse section of root-tips a most characteristic occurrence of chromosomes in pairs was noticed in both the diploid and tetraploid forms. The somatic chromosomes of Narcissus being more or less heteromorphic, the paired association of the homologues is easily recognized in an uncut nucleus (figs. 56, 57, 59). In these figures the homologous chromosomes forming a pair have been marked with the same letter. It is remarkable that only a portion of each homologue



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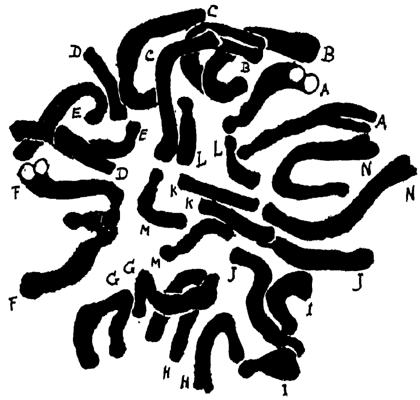

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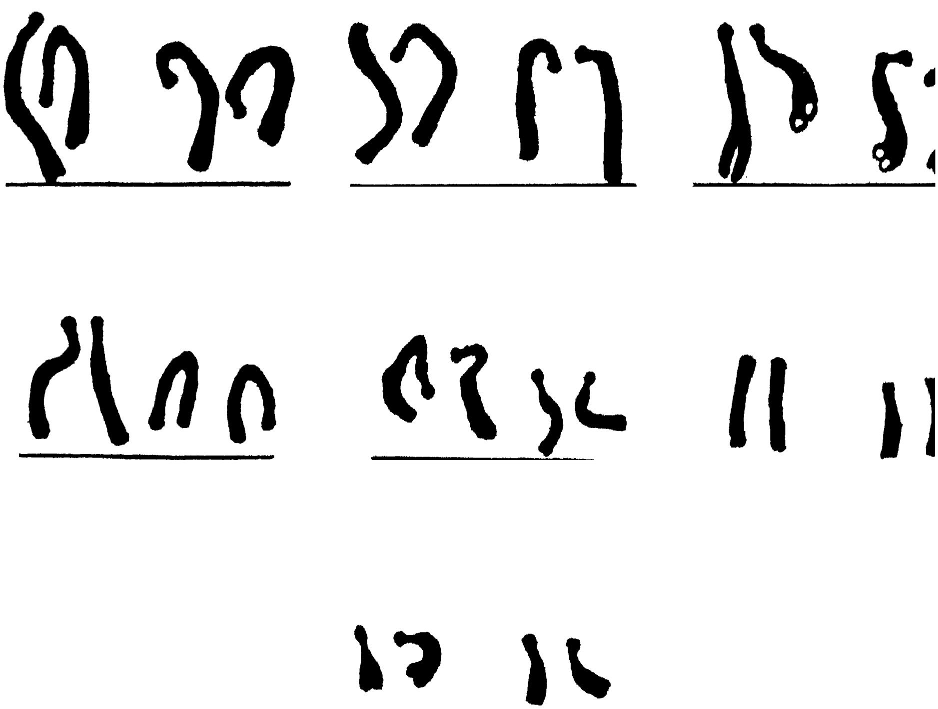

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of a pair is really close to the other—that is to say, they do not pair side by side along the whole length of their body. In figs. 58, 60, each pair has been shown separately. It can be realized that the configuration of the diploid chromosomes (fig. 58) is not the same as that of the tetraploid. In each chromosome of the diploid there is a prominent constricted region, either subterminal or medial, whereas the chromosomes of the tetraploid show no such prominent constricted region. Most of them have a knob-like swelling at the proximal end, with a slightly narrower region just behind the knob ; the others are rod-shaped. From this comparison of the chromosome morphology of the two forms, it is found that the tetraploidy in the case of " Chinese sacred lily " is not a duplication of the diploid form of *Narcissus pseudonarcissus*.

The analysis of the " Chinese sacred lily " chromosomes shows that there are probably fourfold chromosomes of each type, as shown by the underlining in fig. 60.

Pairing of somatic chromosomes on the metaphase plate has been reported by numerous authors. Metz (1916) gives at some length the literature of chromosome pairing in both animals and plants. Bonnet (1914) and Navashin (1915) have doubted the actual existence of pairing as anything more than a chance association of chromosomes of similar size. It should be remembered that it is only in the metaphase that any actual existence of pairing is really demonstrable, and there also frequent interruption of pairing has been reported (Müller, 1912 ; Navashin, 1912). The inference of the occurrence of pairing at the resting stage on the basis of numerical consideration of the prochromosomes is rather unsatisfactory. The view of Overton (1909), Sykes (1908, 1909) and Tahara (1910) that the double spireme of the prophase represents the lateral approximation of the structures derived from the chromosomes of male and female gametes cannot hold good, since the same sort of double spireme has been shown in the dividing pollen nucleus (Fraser and Snell, 1911 ; Reed, 1914). Since the pollen belongs to the gametophyte, no question of pairing of allelomorphs can arise there ; moreover, the segregation of paternal and maternal elements has already taken place in their formation.

The above views of Overton, Sykes and Tahara were put forward to explain the doubleness of the spireme of the prophase stage in contradiction to the views of Farmer and Digby (1910), Fraser and Snell, who regarded the doubleness of the spireme as representing a premature longitudinal fission which would bring about the separation of daughter chromosomes in the next anaphase. The views of the latter group of authors also require modification in the light of recently observed facts (Kaufman, Sharp, and Telezynsky), which will be discussed later.

Discussion.

In the study of the chromosome cycle from one nuclear division to the next, one notices the two most outstanding features, viz., the formation of the chromosomes from the nuclear material before their division, and their dissolution after the division to form the nuclear material of the two new daughter nuclei. In other words, one sees that there is some material, in some form or other, in the nucleus from which chromosomes are built up during the process of division, and after their separation into two equal portions on the spindle, they again go to form the material of the daughter nuclei. So, in a restricted sense, a given chromosome complement may be regarded as a metamorphosed nucleus.

In our description we have discussed some points which have already cropped up in connection with the description of the particular stage. Here we shall attempt to discuss the following points : (I) chromomeres and

chromonema—their relationship in resolving the chromosomes out of the substance of the nuclear network; (II) the duality of the chromosome structure; (III) the split and division of chromosomes.

(I) *Chromomeres and Chromonema—their Relationship.*

As early as 1891, Fol first employed the term chromomere as equivalent to chromosome, but in this original sense it is no longer in use. Later on this term was especially applied to the serially aligned granules of the spireme threads of chromosomes which were formerly designated as Pfitzner's "granules" or Weismann's "ids," and in this sense it is understood in the present-day literature. Wilson (1896) found still smaller bodies composing a chromomere, and to these smallest visible organized parts of the chromosomes, grouped to form chromomeres, Eisen in 1900 gave the name chromioles.

Numerous investigators have described the chromosome threads, at early prophase stage, as containing a linear series of smaller bodies, namely, chromomeres. The fact shows that chromomeres are most readily seen in the spireme threads during earlier stages of mitosis or meiosis, before the condensation of chromosomes has proceeded very far. It is very natural that, during the shortening and thickening of the threads, chromomeres should undergo various changes, often becoming obscure, due to increased chromaticity of the threads at this stage, and in many cases disappearing from view; so that many observers have been unable to find them in the metaphase chromosomes. Consequently, their existence has been disputed by a considerable group of authors, including especially Grégoire and his school and Lundegårdh, who have either failed to find the chromomeres or have considered them as accidental coagulation products due to local differences of density or the like, denying any structural value to their appearance. Sands (1923, 1925) and recently Belling (1931) have shown that preparations from paraffin sections are not good for the demonstration of chromomeres. The latter recommends smear preparations for the study of chromomeres; again, he says that not every plant preparation treated by the best methods shows the chromomeres equally well. He is of opinion that some plants give good results when in a state of rapid development, which could be brought about, according to him, for Lilium and other plants, by raising the room temperature. From the present preparations also we have seen that the prominent presence of chromomeres depends largely on the fixative used, and also on the stage of nuclear division. Thus with Merkel's fixative chromomeres are seen in almost all stages, whereas with other fixatives they are visible only at certain stages as described above. When chromomeres are seen, the threads are like a linear series of smaller basichromatic bodies suspended in a more lightly staining or oxychromatic substance, a type of chromosomic structure we have called chromomeric threads. Again, when the threads are not chromomeric—that is to say, when they are uniformly stained without any granular differentiation along their length—we have

called them chromonemata. From this it appears that there must be some intimate relationship between these two types of structure of the chromatic threads, and one is the transformation of the other under different conditions.

Janssens (1901) believes the threads to arise by the linear aggregation of originally scattered minute basichromatic granules. Dobell (1911) reports the formation of nuclear threads in bacteria from scattered chromidial granules or chromioles. Vejdovsky (1927), working on Vicia and Allium, reported the origin of chromomeres from the telophasic chromosomes. According to him, the chromonema derives its origin by the junction of chromomeres or their derivatives (chromioles), and he regards these chromonemata as "primitive prophase chrômosomes." It should be noted here that, according to him, a single chromonema goes to form a single chromosome. From Vejdovsky's work one can trace a direct origin of the chromonema from chromomeres, whereas the origin of chromomeres from the chromonema does not appear to be so direct.

Bonnevie (1908, 1911) reports the origin of spiral filaments (chromonema) from the telophasic chromosomes endogenously. According to her, the chromatic element of chromosomes differentiates into a form of winding spiral running uninterruptedly from one end of the chromosome to the other, the achromatic element of which forms the inner substratum. This achromatic element becomes quite unstainable, and at last disappears in the nucleoplasm, leaving free the spiral filaments in it. Unlike Vejdovsky, Bonnevie considers that the chromonema arises directly from the chromosome without an intervening chromomere stage. She does not recognize any chromomere stage in the development of the chromonema.

Both Vejdovsky and Bonnevie have started to trace the origin of the chromonema from the beginning of the telophase transformation of the chromosomes, regarding the chromosomes before that stage to be homogeneous and of uniform structure. It is very interesting to note that this telophasic transformation of the chromosome has been so variedly described by different authors, sometimes working on the same material. We have seen how Grégoire and his school see alveoles in the chromosomes, whose multiplication and growth transform the telophasic chromosomes into a network of networks (reseau de reseau) of the resting nucleus. Again, we have also seen how Bonnevie inclines to describe the telophasic transformation as producing free chromatic spiral threads anastomosing in the resting nucleus and giving rise to a network structure of the nucleus. But in the light of the present work and that of Kaufman (1926), Sharp (1929), and Telezynsky (1930, 1931), who have observed the dual structures of chromosomes, composed of two chromonemata intertwined and interlaced with each other with a less chromatic matrix to support them, we think we have sufficient reason to state that all the above descriptions of the telophasic transformation of the chromosomes by Grégoire, Vejdovsky, and Bonnevie are faulty interpretations, failing to recognize the dual structure of chromosomes at the immediately preceding stage of anaphase. We have already

shown how, when a chromosome is composed of two intertwining chromonemata, it may give the appearance of alveolar or vacuolar structure of the chromosomes, especially when the interspaces between the crossing points are larger and the less chromatic substance has disappeared in the nuclear sap. It is most likely that one who has failed to see duality of chromosome structure at the anaphase would mistake these interspaces between two intertwining chromonemata either for vacuoles (Grégoire) or hyalomeres (Vejdovsky), and their crossing points as chromatic globules, and the same failure explains the whole further erroneous proceeding in the explanation of the telophasic transformation. Again, as the twining of two chromonemata from opposite directions may produce a vacuolar appearance of their interspaces, similarly, if they start twining in the same direction, they would, no doubt, produce such a structure of the chromosome as Bonnevie describes, namely, a chromatic thread winding round an achromatic core. This type of winding of the chromonemata may happen sometimes, as has already been described, and can be seen in fig. 4. So it can be said with sufficient ground that the spiral filaments which Bonnevie describes in the telophase are identical with the chromonemata of the present case and of the authors mentioned above.

Enzio Reuter (1930) mentions as many as 67 zoological and botanical investigators who have reported chromomere structure in some stage or other of the chromosomes. Wenrich (1916) demonstrated that in Phrynotettix chromosomes the chromomeres differ in size and position in the various chromosome pairs at the late pachytene, and show a remarkable constancy of serial arrangement. Belling (1930), working on liliaceous plants, has ascertained the count of chromomere numbers in the early state of meiosis. In the pollen mother-cells of Lilium (consequently in all its other diploid cells) he has been able to count up to about 2,500 pairs of chromomeres. He recognizes chromomeres of different sizes, and further associates chromomeres with genes, considering a chromomere as a gene with a covering of chromatin, the different sizes being due to different volumes of chromatin in different genes. This enveloping chromatin of the genes he calls "gene chromatin," and in later stages, especially when the threads begin to zigzag, "extra chromatin" binds the zigzag. From Belling's observation it becomes clear that he, like Vejdovsky, demonstrates the formation of chromonema from chromomeres by the deposition of extra chromatin on them. According to him, at late diaphase and early telophase this extra chromatin reaches its maximum. It should be noted here that Belling does not adopt the name chromonema, although from his description it appears that the granular threads become uniform through the action of extra chromatin, thus showing the intimate relationship between chromomeres and chromonema—one giving rise to the other according to the condition and stages of nuclear division. The intimate relationship is further shown from the present case by the chromonema giving rise to chromomeres by their disintegration at the end of the telophase, when almost every chromonema becomes chromo-

meric. The chromomeric structure of the chromonema we have seen to persist through the resting stage and early prophase, again becoming chromonemic in the late prophase and metaphase. Again, with the beginning of anaphase in some cases (fig. 3), the chromonemata begin to show chromomeric structure and in other cases do not, depending upon fixation and staining, as has already been described. From this one can conclude that the chromomeric or chromonemic structure of the chromatic thread is the different structure of the same thing under different conditions and at different stages.

The existence of chromomere structure in chromosomes has been strongly criticized by Lundegårdh, but his consideration of karyosomes indirectly contributed to prove the existence of the chromomeres. He asserts that in the living condition chromosomes are smooth, and that only after fixation their surface " seems to be composed of Pfitzner's granules " (chromomeres). Recently Chambers, by means of his ingenious micro-dissection apparatus, has shown *in vivo* that chromomeres can be seen as paired swellings in the diplotene stages of the spermatocytes of grasshoppers, and when stretched with a micro-dissection needle they are not destroyed, but only moved further apart.

(II) *The Duality of Chromosome Structure.*

The consideration of duality of chromosome structure involves two separate aspects : (i) the continuity, (ii) the constituents of the chromosomes in mitosis.

(i) *The Continuity of Chromosomes.*—It is a well-known fact that chromosomes have permanence as one of their properties. That is to say, the continuity is maintained, not only from generation to generation of species, but also in the body of the organism itself, by the mechanism of mitosis, the main result of mitotic division being the separation of the chromosomes into two equivalent portions on the spindle.

This phenomenon is continually being repeated wherever the process of mitosis is taking place in an organism ; but when we come to the question of the form in which the continuity of chromosomes is maintained, then we are confronted with diverse views. Any clear conception of this matter must be based upon the nature of the transformation from telophase into the resting stage. Up to the present time the interpretations of this relationship by various authors can be grouped in the following way :—

1. Grégoire and Wygaerts (1903), Grégoire, Sharp (1913, 1926), R. De Litardière (1921), Němec (1899), Müller and Overton, maintain the alveolization of the telophase chromosomes, while in the beginning of the prophase the chromosomes turn into long filaments.

2A. This group of authors admits the occurrence of alveolization in the telophase or even in the anaphase chromosome, but the alveoli are only along the longitudinal axis of the chromosomes, causing their split. They maintain that the duality of the prophase filaments belongs to the telophase or even to the anaphase. Lundegårdh, Fraser and Snell, De Horne (1911), Digby (1910, 1912), Schustow (1913), and Sarbadhikari belong to this group.

2B. Bolles-Lee also maintains the duality of the prophasic thread belonging to the previous telophase, not as a result of longitudinal split of the chromosome at that stage, but by transverse segmentation at the apex of the V-shaped chromosomes of the telophase. He, like the authors of the following group, observes the intertwining aspect of the chromo-

somes, but this intertwining, he thinks, takes place between the arms of the V-shaped chromosomes.

3. To this group of authors belong Kaufman (1926), Sharp (1921), and Telezynsky (1930, 1931). They, like the second group of authors, maintain that the duality of prophase filaments belongs to the telophase and anaphase chromosomes, not, however, as a result of longitudinal splitting by the process of alveolization. They regard the duality as inherent in the structure of a chromosome composed of two chromatic threads (chromonemata), and the origin of the double chromonemata as taking place by "internal organization" of the mother chromosome in the previous late prophase (Kaufman). The loose intertwining of chromonemata in the telophase is believed to produce the vacuolate appearance in the chromosome, the "vacuoles" being really but the interspaces between arcs of the chromonemata, the latter maintaining the continuity of the chromosomes.

4. To this last group belong Janssens, Bonnevie, Vejdovsky and Martens. According to them, prophasic threads are single filaments arising from the telophasic chromosomes, though the method of the origin of the single thread has been described differently by every one of them.

From the above grouping it is understood that the chromosomes are continued from one division to the other, either in a single form (groups 1 and 4) or in a double form (groups 2 and 3). When continued in a single form, they are said to become double by longitudinal split or by bilateral repartition of the chromosome-forming material at the prophase. One of the vigorous upholders of the former view was Sharp (1913, 1926); but from the result of reinvestigation of some of his previous works (1929), he has given up his original view, and now he considers that chromosomes are continued as dual structures from one division to the next, the division of each dual structure taking place at the late prophase, giving rise to a quadruple structure of each chromosome at that stage.

When they are continued in a double form, the doubleness has been explained either as due to the longitudinal split or transverse segmentation (group 2, A and B) in the previous telophase and anaphase, or due to the inherent structure of a chromosome, being composed of two chromonemata (group 3). Now the question stands: Which of the two—the longitudinal split or the duality of structure—is the correct explanation of the doubleness of the chromosome structure? If we regard the doubleness as the result of split chromosomes, then we come to an indefinite conclusion that the split takes place in almost any stage of nuclear division, namely, prophase, metaphase, anaphase, and telophase; and a dividing nucleus is virtually double, the continuity being maintained with the double number of chromosomes from one division to the other. If such be the case, then we do not know yet what is the actual $2n$ number of chromosomes of a given species, and we would not know at what stage a nucleus contains the actual number of chromosomes for the species.

It is very natural to regard the number of anaphasic chromosomes in a mitosis on their passage to each pole as the $2n$ chromosome complement of a given species. In these anaphasic chromosomes also doubleness has been observed, and we have already mentioned those authors who regard these chromosomes as showing a split for the next division. Kaufman, Sharp and Telezynsky have described the doubleness of anaphasic chromosomes, and this has also been observed in the present case, continuing to telophase and reappearing in the next prophase. Again, Kaufman and Telezynsky have

observed the quadruple structure in the double chromosome threads of the late prophase stage. Similar structure has been suggested by Sharp at that stage. In the present case we have observed the quadruple structure in the metaphase equatorial plate of Narcissus.

From the above facts two explanations of the doubleness of the chromosomes from anaphase to next prophase, and quadrupleness in the late prophase or metaphase, are possible. The first one is that if the chromosomes be regarded as homogeneous in structure, then the doubleness is the split showing one division ahead of the separation in mitosis; and the quadrupleness is due to the split showing two divisions ahead. The second is that the doubleness is the inherent structure of a chromosome composed of two intertwining chromonemata, and splitting takes place in the individual chromonema either at the late prophase (Kaufman, Sharp, Telezynsky) or in the metaphase, as shown in the present case, thus producing two chromonemata for each chromosome of the anaphase.

The apparent homogeneity of the chromosomes is due to the method of staining followed, and also partly to the fixative used, but that they are not homogeneous structures has been shown by numerous authors already mentioned. When properly fixed and stained, the dual structure of the chromosome becomes clearly visible. Moreover, Kuwada and Sugimoto (1926) have demonstrated them in fresh meiotic chromosomes with neutral violet extra, and Telezynsky has shown them in the mitotic chromosomes of Tradescantia in living preparations. Therefore we can conclude that homogeneity of chromosome structure is more of an artefact than real.

The hypothesis of Fraser and Snell (1911), and Digby (1919), which maintains that doubleness is due to division, that each prophasic chromosome is formed of two units derived from a single chromosome, and that the units of each pair are separated during the subsequent division, can hold only so long as no quadruple structure of the chromosomes is observed. It should be remembered that Fraser and Snell propounded the above hypothesis on the basis that anaphasic chromosomes are single. Lundegårdh (1910, 1912*a*) made observations on the same material (*Vicia faba*), and came to the conclusion that the anaphasic split is quite as evident and distinct as the split in the prophases. Curiously enough, Lundegårdh holds with Fraser and Snell that each chromosome appears from the resting reticulum already double as a result of longitudinal split in the previous division, although he neither says, nor do his figures show, at what stage the chromosomes are single and when the initiation of the longitudinal split takes place. In his figs. 52*a*, 52*b* (1912*a*) and fig. 10*a*, *b* (1910), where he draws some anaphasic chromosomes showing already clear doubleness, it looks as though each chromosome is composed of two chromonemata which have not yet intertwined with each other; and his fig. 54 of telophase clearly shows the intertwining as well as the parallel association of the parts, as shown in some of our figures of the corresponding stage. In the investigations of Kaufman,

Sharp and Telezynsky, and in the present case, the dual structure of anaphasic chromosomes is shown from the very beginning of the anaphase. This conclusively proves that the duality is the inherent structure of the chromosome, and not due to the split of the chromosome, because when the split of these dual structures takes place, a quadruple structure results in the late prophase or metaphase, as has already been mentioned. To consider this quadruple structure as showing two divisions ahead of a mitosis is, in our opinion, an unnecessary deduction from the observed facts; moreover, one cannot find any reason why chromosomes should show a split two cell generations in advance, although the mitosis is going on in each cell generation. On the other hand, according to the theory of dual structure of chromosomes, the quadruple structure is due to the division of each constituent chromonema of a chromosome, producing two chromonemata for each sister chromosome about to be separated in the anaphase. Therefore the doubleness of the anaphasic and telophasic chromosomes and their reappearance in the next prophase should not be regarded as split chromosomes, but rather as two chromonemata for each chromosome. Thus the continuity of the chromosomes by their chromonemata is being maintained.

(ii) *The Constituents of the Chromosomes in Mitosis.*—In addition to two chromonemata for each chromosome, there has also been described a less chromatic matrix in which the chromonemata are embedded and which serves the purpose of supporting them. From this point of view, again, the chromosome may be regarded as dual in structure, the constituents being the chromatic element (in the form of chromonemata or chromomeres) and the less chromatic matrix. These double constituents have been observed even by investigators who have failed to see the chromonematic nature of the chromatic element (Grégoire, Fraser and Snell, Overton, etc.). Regarding the presence of these two constituents in the chromosomes, at least at certain stages, there is no discrepancy among the investigators of chromosome structure, but whether these dual constituents persist throughout the chromosome cycle of mitosis is a question which has not yet been settled. Bonnevie thinks the less chromatic substance disappears in the nucleoplasm, leaving the chromatic element free in the nucleus. Martens, on the other hand, asserts that the less chromatic matrix persists from one division to another, accompanied throughout the cycle by its own chromatic elements. Kaufman, in discussing the question of the disposition of the achromatic material, suggests that the karyolymph is a direct product arising from the achromatic material of chromosomes composing the daughter nuclei. According to him, the substance of the matrix becomes continuous with the karyolymph by giving origin to that substance, and the chromatic element in the form of spiral chromonemata maintains the genetic continuity of the chromosome through the ensuing interphase without being accompanied by the less chromatic material. He further describes the reappearance of the chromatic substance *de novo* from the chromomeres of late prophasic chromosomes.

These he believes to be the active centres at which a new differentiation of achromatic substance is beginning. Sharp (1929) is not very definite in his opinion whether the dual constituents of the chromosome are maintained throughout the cycle of mitosis or not. In one place he says: "I have inclined to the opinion that the chromosome matrix and the fluid entering the nucleus during the telophase intermingle to form the transparent karyolymph of the interphase and metabolic stage." Here Sharp partly agrees with Kaufman in thinking that the achromatic matrix goes to form in part the karyolymph, though not all of it. The rest he presumes enters the nucleus from outside. Again, in connection with the description of the prophasic stage, he says: "I incline to the view of Martens that the matrix exists throughout this stage as a thin layer about the chromatic threads and as small accumulations held in their curves. The alternative view is that of Kaufman, who believes the matrix substance to differentiate anew in the later prophase, only the chromonemata preserving the identity of the chromosomes through the interphase and early prophase." It seems strange that Sharp could hold the opinions of both Martens and Kaufman at the same time, when it is definitely clear that the former asserts that the two substances remain distinct, and the genetic continuity of chromosomes is maintained by them together; while the latter clearly expresses the view that one of the two substances is transformed into karyolymph, the genetic continuity being maintained by the other.

Although the subject of the less chromatic component of the chromosomes and its relation to the karyolymph has yet to receive a comprehensive solution, it has been observed, in the present investigation, that the association of the less chromatic substance with that of the chromatic elements of the chromosomes does not remain always the same. During telophasic transformation of the chromosomes the less chromatic substance has been considered to disappear from the matrix of the chromosomes at the same time as anastomoses between the chromosomes have been noticed, and these anastomoses are seen to persist in certain cases to the early prophase. In the prophasic chromosomal bands the less chromatic matrix again becomes prominent as soon as the anastomoses are drawn in. From this cytological correlation between the appearance and disappearance of the anastomoses and the disappearance and appearance respectively of the less chromatic substance in the chromosomes, one may be justified in concluding that the continuity of the chromosomes is maintained in their double constituents throughout the cycle, though not in the same type of association. Rather we may conclude that there are different types of association at different stages of division, viz., the achromatic substance as matrix and the chromatic elements as skeleton in it, during the late prophase, metaphase, and anaphase, and as anastomoses connecting the chromatic elements during the telophase, interphase, and early prophase.

(III) *Division of the Chromosome.*

In view of the double chromonema structure of the chromosome, our ideas about the division of the chromosome have to be revised to a certain extent. So long as the dual structure of the chromosome was not known, investigators, at whatever stage they happened to observe the doubleness in the chromosome, used to call it longitudinal splitting. On this account there was no certainty about the time when the division of the chromosomes occurred. From the theory of double chromonema structure, the doubleness seen in the chromosome is to be taken as the structure of the chromosome (consisting of two chromonemata), and the division of the mother chromosome is brought about by the division of each of the constituting chromonemata. In this sense the actual division is no longer of the chromosome, but of the chromonema, because as soon as the division of the chromonema takes place, the division of the mother chromosome automatically follows, resulting in two chromonemata for each sister chromosome. Consequently, the time of the division of a chromosome is concurrent with the division of the chromonema. So at whatever stage of mitosis the quadruple structure of a chromosome, i.e., a chromosome consisting of four chromatic threads, is formed, that stage should be regarded as the time of division of the chromosome.

Up to the present time the investigators (Kaufman, Sharp, Telezynsky) who have been able to observe the double chromonema structure have described the division of the chromonema initiating in the late prophase and progressing with the advancement of the stage to the metaphase. In the present case no sign of division of the chromonema could be seen in the late prophase stage; the reduplication of the chromosome halves is first clearly seen only when they have arranged themselves on the equatorial plate. Considering our failure to detect the division of the chromonema in the late prophase as negative evidence against Kaufman's observation, let us see how far Kaufman (1926*a*) was correct in his observations of the above phenomenon. At two places in his figures (figs. 47 and 48) of the late prophase stage he attempted to show the division of each chromonema of the chromosomic threads. The former is apparently a drawing of a cut nucleus. In this figure, at *a*, he points out the chromonema showing division; but this may be a case where one of the chromosomic threads is folded over near the margin of the nucleus, thus giving the impression of reduplication in the chromonema, and he himself admits that "the evidence is too slight to be valuable." The fig. 48, from which he obtains "the first accurate information," is drawn separately of a projecting end of a late prophase chromosome, later than that of fig. 47, but before the dissolution of the nuclear membrane. Although clear duality is shown in the drawing, yet too much reliance cannot be placed on this piece of evidence, because one cannot judge the real nature of the duality from an isolated drawing unless one has the opportunity of comparison with other threads of the same nucleus. This may be also a case of folding over of one of the threads. The

clear case of duality, however, in the halves was noticed by Kaufman at the equatorial plate stage, as shown in his fig. 54.

Sharp (1929) does not feel sure, from his observational facts, of the chromatic duality in each half at the late prophase stage, so he says: "Direct and convincing evidence on this point is not easily obtained. In the late prophase chromosomes shown in figs. 44, 45, and 47, there are suggestions of doubleness at certain points (indicated by arrows), but the real significance of these aspects cannot be evaluated safely at present," but he recognizes that "the chromatic duality is evident in each half of the double metaphase chromosome."

Similarly, Telezynsky (1930), although he finds difficulty for himself in observing it under the microscope, thinks that his camera is able to detect and reproduce it in the photograph, as he says: "Cette image peut nous suggérer la pensée que l'on ait ici affaire à un commencement du dédoublement du chromonéma—phénomène qui est difficile à observer chez cet objet, mais que l'on peut, néanmoins, apercevoir sur la photographie." One can hardly make out any sign of reduplication of chromonema in his photograph of the late prophase stage.

From the above statements of the authors it is particularly clear that every one of them is suggesting the reduplication of the chromonema in the late prophase on the basis of very meagre and unsatisfactory evidence, but the actual reduplication every one of them sees only in the metaphase stage, as is also manifested in the present case. So it is quite possible that the absence of any indication of reduplication in the late prophase chromosome halves of Narcissus may not be regarded entirely as negative evidence against the observation of these authors, remembering that we are dealing with a different genus altogether. Now, leaving aside the question of the indication of the reduplication of the chromonema in the late prophase stage, we see that, in accordance with our observation in Narcissus, the above-mentioned proponents of the theory of dual chromonema structure have also seen the actual reduplication of the chromosome halves (chromonema) in the metaphase equatorial plate stage.

Having established the time of the reduplication of the chromonema, its nature must be considered. It has already been shown that the division of the chromosome is effected by the reduplication (division) of each chromonema. The manner in which the reduplication takes place is not clearly known at present. Kaufman's explanation (1926*a*) of the mechanism of the reduplication by such terms as "internal reorganization or endogenous formation of chromonemata" actually does not throw much light on the understanding of this difficult question, but very well serves the purpose of hiding our ignorance of the matter. He thinks that the introduction of the "endogenous" chromonema formation is coincident with the coiled form of chromosomic threads. While making this statement, he forgets that at the late prophase stage, where he thinks the internal reorganization is taking place in the halves to produce the chromonemata, the chromosomic threads

are far from being in coiled form as his figs. 45, 46, 47 and 49 show. It is true that some of them are in intertwined condition, but none of them are in spirally coiled form ; and he himself says, and shows in his figures, that the threads are in coiled form only in the early prophase stage. As the prophase advances, the threads become more extended, parallel and thickened (fig. 49). Again, he says the phenomenon of coiling " is perhaps associated with the conservation of space, since the coil is a more compact unit than the extended thread." Here, too, Kaufman misses the fact that with the progress of the prophase the nucleus grows to its maximum volume ; hence, as compared with its earlier stage, there cannot be any dearth of space. Consequently, " the phenomenon of coiling " cannot be compatible with " the conservation of space," and actually, at least at the late prophase stage, there is scarcely any phenomenon of coiling even in his figures.

Sharp (1929), on theoretical grounds, expects the initiation of the division of the chromonema to take place in the middle prophase, when they are relatively slender, but he does not mention what is his theory and what is the requirement of the theory that the chromonema must be slender to undergo division. On the other hand, he also suggests that the chromonema may become double by actual fission, like the process of division of other protoplasmic units such as cells and plastids. It is well known that the division of these organic units depends on their growth and absolute mass —that is to say, when their growing mass reaches a certain critical value—but this is by no means true of the chromonema at the middle prophase, when they are slender. They undoubtedly continue to grow with the advancement of the prophase stage, and the perfect attainment of growth and its critical value naturally must be at the metaphase. Again, it is in the metaphase that the close association of the chromosome halves (chromonemata), so long existing from the previous anaphase, is about to culminate, and they have to be parted from each other. Is it not natural that the fission should take place in the halves (chromonemata) in accordance with the fission of other protoplasmic units at this critical moment of the history of chromosomes ? The chromosome halves of Narcissus show clear fission at this stage of metaphase when they have been arranged on the equatorial plate (figs. 51, 52).

The explanation for longitudinal division was first put forward by Roux (1883), who conceived the differential character of the chromatin and its linear organization, otherwise, he asserted, the complicated process of mitosis would be meaningless. Accordingly, the arrangement of these qualitatively different chromatic materials in the form of a long thread prior to its splitting is a means by which all the qualities arranged in a linear series in the thread would be equationally divided and distributed to the daughter nuclei after the splitting. This explanation of Roux was based principally on the observation of Balbiani and Pfitzner, and strengthened the conception of the nucleus as an organ of heredity, and the chromosomes as bearers of hereditary characters carrying the chromatic bodies (chromo-

meres) in a series in the chromosomal thread of the prophase. Later it was believed (Strasburger) that the division of these chromomeres initiates splitting of the chromosome. Thus the importance of the chromomeres more than the chromosomes on which they lie grew among many cytologists, who thought that these chromomeres bore some relation to the qualities of Roux. Since then they have been associated with "ids" and "genes." Recently Metz (1925) has asserted that "the function of longitudinal division would be to divide each of these materials accurately and bring about an equal distribution to the daughter cells. This view has received more and more support as cytological experiments have progressed in recent years."

Although there are many instances in which chromomeres show remarkably regular arrangement and division during mitosis, yet there is much doubt whether they can be regarded as significant autonomous units. This has been clearly shown by their intimate relationship with the chromonema formation in the present work. In that case one cannot be very certain of the observational evidence that the chromosomes are qualitatively different along their length, and whose equal division and distribution it is the function of this longitudinal fission to bring about. As McClung (1927) points out, "This feature of mitosis, which inspired in Roux the conception of the differential character of the chromatin and its linear organization, is very simple in principle, but is, as yet, inexplicable in operation. Why and how does the chromosome become longitudinally split in each mitosis? The teleological answer is ready at hand, but what immediately occasions this profoundly significant but very simple action remains without determination." Gates (1911), on the other hand, says: "It may be pointed out that this longitudinal fission of the viscous chromosome-bodies may be determined by purely physical forces resulting, for example, from the electrical charges carried by the chromatin particles." He further adds: "If this were the case, instead of an equal distribution of 'ids' to each daughter chromosome, longitudinal fission would mean merely fission for mechanical or physical reasons along whatever becomes the longitudinal axis of the chromosome as it changes from the reticulate condition of the resting nucleus to the compact condition of prophase or metaphase. There is no observational evidence that longitudinal fission means any more than this, nor that in the passage from the alveolate or reticulate condition of the resting nucleus to the compact condition of the prophase, any particular arrangement of differential units of structure composing an individual chromosome takes place. . . . But it may be for purely physical reasons that a somatic chromosome always splits longitudinally. It is not necessary to assume that the function of this split is to produce an equal division and distribution of 'ids' arranged along its axis."

It must be remembered that the above statement was made twenty years ago, when there was very little cytological evidence, on a genetical basis, to show that the chromosomes may be qualitatively different along their length.

But considering the contribution made since then to our present knowledge in support of the chromosome theory of heredity (Morgan, 1925), especially the explanation offered on the basis of the theory of crossing-over, we cannot but assume qualitative differentiation along the length of the chromosome. Again, as there is no inherent difference between the chromosomes of germ cells and somatic cells, then the explanation of the peculiar behaviour of longitudinal splitting may be sought on Roux's hypothesis; but what immediately occasions the longitudinal splitting may be a purely physical reason, as Gates thought twenty years ago.

On the basis of the chromonema structure of chromosomes and the data supplied from the present observations, we think it is possible to co-ordinate and harmonize the view of Roux as the explanation of the longitudinal split and the physical reason as the immediate cause, as Gates suggested, in the following way. The foundation of the chromonema is the ultramicroscopic thread of genes (Earl, 1927); these threads have fluctuating attraction for chromatin as a whole, and, again, certain genes or groups of genes may show greater attraction for chromatin than others. The result is the chromomeric appearance of the chromonema. However, the chromatic acquisition of the gene threads reaches its critical value when the chromonema is at the metaphase stage, and becomes uniformly chromatic and attains the maximum volume. Splitting follows in the chromonema. The splitting of the chromonema necessarily brings about the division of the internal framework of the chromonema, namely, the gene thread.

We have noticed that the splitting and twisting of the chromonema were more or less simultaneous processes. The explanation of this twisting can be very convincingly sought on the basis of the gene thread conception of the chromonema. As Earl (1927) states, "If the genes are regarded as the basis of the chromonema, and considered as restricted to division at each mitosis in a plane parallel to the long axis of the chromosome, they may be thought of as dividing in every vertical plane in a haphazard way. Mutual repulsion of like products of division would tend to separate them as far as possible. But since the genes are regarded as arranged in linear order and presumably attached to each other in some way, since they maintain this arrangement, separation will not be a simple matter, the longitudinal split having occurred in various planes. On this account the two new threads would be thrown into the semblance of a spiral, although twists in one direction at certain places would largely be compensated by a twist elsewhere the opposite way. This twisting with repulsion would greatly shorten the distance the threads cover, thus producing the chromosome as we know it." So the twisting of the chromonemata just after their splitting may perhaps be considered as a manifestation of gene attraction and repulsion at certain points on opposite chromonemata, thus producing gene arrangement in somewhat spiral ways within the chromosome.

So we come to the point that on the hypothesis that chromonemata carry the genes and split lengthwise at each mitosis, as has been seen in the present

case, the theory of the gene would be in harmony even if a chromosome is composed of two chromonemata, because it is immaterial what may be the number of chromonemata in a chromosome if that number remains constant. This, in a way, also helps in solving the difficulty of Kuwada (1927), who remarked: "The question whether in somatic chromosomes there is one spiral or two may have the same significance in the problem of the mode of chromosome conjugation as has the question whether the anaphasic or telophasic splitting of chromosomes really takes place or not." According to the view of anaphasic or telophasic split of the chromosome, the mode of chromosome conjugation must be telosynaptic (Digby) because doubleness seen in the prophase of meiosis cannot be regarded as the condition of pairing, but as the vestige of longitudinal split of the chromosomes; so the chromosomes must conjugate end to end. On the other hand, according to the theory of two spirals in the structure of the chromosome, both telosynaptic and parasynaptic modes of conjugation are explicable, as, when the chromosomes are conjugating end to end, the doubleness seen in the prophase is due to two chromonemata present in the chromosomes, and in the case of side-by-side pairing a quadruple structure should be seen, which has been actually observed in many cases at the diplotene stages of meiosis. The failure to observe quadrupleness in the earlier stages might be due to thinness and close approximation of the thread during those stages.

The occurrence of both the modes of chromosome conjugation has been reported by numerous competent observers, not only in different but also in the same object. The fact that the same objects have been so differently described by two schools suggests that interpretation is largely responsible for the persistent diversity of opinion. The two interpretations differ mainly in connection with the appearance of the doubleness or quadrupleness seen in the chromosomic threads of the later prophase and metaphase of the heterotypic division. There can be little doubt that all these diverse interpretations are only due to failure to recognize the duality of chromosome structure composed of two chromonemata.

Summary.

1. From a study of mitosis in the root-tips of Narcissus, it is shown that the anaphasic chromosomes are structurally double, being composed of two more or less intertwining chromatic threads (chromonemata) supported by a less chromatic matrix.

2. The dual structure is temporarily obscured at the end of anaphase, but reappears with the beginning of telophase.

3. During telophase the chromonemata untwine and become chromomeric.

4. The resting nucleus, in general, is not a reticular structure. The nucleus is seen to be composed of parallel strings of chromomeres representing the chromonemata.

5. In the early prophase the dual structure of the chromosomic bands is

obscured or revealed, according to the fixatives used and staining followed. Later they shorten and thicken, and each forms a half chromosome.

6. The fully formed doubly constituted chromosomes, which are generally regarded as split chromosomes, arrange themselves on the equatorial plate. In each half chromosome (chromonema) a cleavage appears, dividing it into two chromonemata. Thus a quadruple structure of the chromosomes results at metaphase.

7. The continuity of the chromosomes is maintained by their constituent chromonemata throughout the cycle of mitosis, though they may undergo transformation, the chromonema becoming chromomeric and, again, chromonemic, showing the intimate relationship between these two types of structure of the chromatic threads.

8. Evidence exists that the chromosome consists of two substances—chromatin in the form of two chromonemata, and a less chromatic matrix, the latter sometimes appearing in the form of anastomoses, and sometimes as the ground substance for the chromosome in the cycle of mitosis.

9. The chromosomes are thus dual structures throughout the mitotic cycle, and the metaphase split separates chromonemata which will ultimately be disjoined in the following mitosis.

10. The mechanism of division of the chromonema is of a physical nature, probably, like that of other protoplasmic bodies, depending on the maximum amount and critical value of their growth.

11. The theory that chromonema indicates the presence of a thread of ultramicroscopic genes is supported, and a suggestion is made that the cleavage of the chromonema brings about the longitudinal division of the gene thread. This harmonizes the views of Roux and Gates as to the cause of the longitudinal splitting.

12. It is shown that the duality of the chromosome structure is in no way in disagreement with the modes of chromosome conjugation, as Kuwada fears. It rather helps to explain more clearly the occurrence of both the parasynaptic and the telosynaptic modes of conjugation observed in the same organism.

In conclusion, I take the opportunity to express my heartfelt gratitude to Prof. R. Ruggles Gates, F.R.S., under whose supervision this work was done.

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EXPLANATION OF PLATES.

All figures were drawn with the aid of a Reichart camera-lucida at table level, with Koristka $\frac{1}{12}$-inch oil immersion, N.A. 1·30, and Zeiss ocular No. 15, and immersed aplanatic condenser, N.A. 1·4, except fig. 53, which was drawn with Zeiss ocular No. 18.
Magnification of all figures, except fig. 53, is × 3,000. The magnification of fig. 53 is 3,800. Special care was taken to obtain critical illumination as described on page 351. Plates reproduced without alteration.

PLATE I.

Fig. 1.—Beginning of anaphase, polar view, sister chromosomes showing intertwined chromatic threads or chromonemata; terminal indentations in some of the chromosomes suggesting the free ends of the two chromonemata.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 2.—Anaphase: a little later than above, side view; chromosomes of various shapes showing different degrees of intertwining of their chromonemata, with the less chromatic matrix in the interspaces between them; chromosome *a* shows that the two intertwining chromonemata have crossed each other at five different points.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 3.—Four anaphase chromosomes still later than above, drawn separately, showing different degrees of intertwining of their chromonemata; *a* shows four points, *b* and *c* three points, and *d* only one point where the chromonemata have crossed each other.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 4.—Anaphase: chromosomes moving to the poles; chromonemata showing different types of association with each other: *a* showing the intertwining of the chromonemata; *b* showing their parallel coiling: *c* showing the optical section of the chromonemata. Free ends of the chromonemata seen in most of the chromosomes.
Tetraploid. Hermann. Iron-alum hæmatoxylin.

Fig. 5.—Anaphase: later than above, chromosomes showing the duality of the chromatic elements.
Diploid. Flemming. Iodine gentian-violet.

Fig. 6.—Anaphase: chromosomes homogeneously stained.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 7.—Telophase: chromosomes relaxing from the polar clumping, undulating outlines of chromosomes indicative of intertwined chromonemata.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 8.—Telophase: little later than above, chromosomes showing intertwined chromonemata more clearly.
Diploid. Flemming. Iodine gentian-violet.

Fig. 9.—Telophase: chromonemata showing parallel association and chromomeric structure. At *a* and *b* some persistency of intertwining is indicated.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 10—Telophase: daughter nuclei forming; chromonemata parallel and chromomeric; at *a* projecting portion of a chromosome showing twisting of the chromonemata.
Tetraploid. Merkel. Iodine gentian-violet.

Figs. 11–13.—Telophases: chromosomes showing the loosening out of the intertwined chromonemata; note the anastomosing connections between the chromonemata.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

PLATE II.

Fig. 14.—Telophase: chromosomes showing spiral chromonemata.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 15.—Advanced telophase: chromosomes showing untwining of the chromonemata.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 16.—Advanced telophase: Untwining of the chromonemata in progress.
Diploid. Flemming. Iodine gentian-violet.

Fig. 17.—Advanced telophase: Untwining of the chromonemata has taken place in all of the chromosomes; chromonema becoming chromomeric.
Diploid. Flemming. Iodine gentian-violet.

Fig. 18.—Telophase: some of the chromosomes are projecting out of the general mass; chromonemata showing already chromomeric structure.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 19.—Advanced telophase: chromosomes showing loosening out of the intertwined chromonemata and their untwining.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 20.—Telophase completed: chromonemata have untwined and are associated parallel, showing chromomeric structure.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 21.—Interphasic nuclei: individuality of the chromosomes is not lost; each chromosome showing two parallel chromomeric chromonemata.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 22.—Interphase passing to prophase: nucleoli showing irregular outline; chromonemata associated parallel and showing chromomeric structure.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 23.—Interphase passed to prophase: chromonemata have become slender and looping in the nucleus; note the chromomeric structure.
Diploid. Flemming. Iodine gentian-violet.

Figs. 24, 25.—Resting nuclei: chromomeric chromonemata are running parallel with each other and showing anastomosing connections between them; at *a*, persistency of the intertwined chromonemata is indicated.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Figs. 26, 27.—Early prophases: spiral chromosomic threads, duality visible at some points.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

PLATE III.

Fig. 28.—Prophase: spiral chromosomic threads showing regular orientation; chromonemata appearing double only at certain regions; note the anastomosing connections between the bands.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 29.—Same stage as fig. 28, but with doubleness showing clearly.
Tetraploid. Bouin. Iodine gentian-violet.

Fig. 30.—General aspect of the nucleus in middle prophase: doubleness evident almost throughout the bands; note remnants of anastomosing connections.
Tetraploid. Bouin. Iodine gentian-violet.

Fig. 31.—Beginning of prophase of the interphasic nucleus: individuality and doubleness clearly maintained.
Diploid. Flemming. Iron-alum hæmatoxylin.

Figs. 32, 33.—Early prophases: doubleness of the spiremes showing clearly; chromomeric structure visible in each chromonema.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 34.—Prophase, showing the looping of the double threads.
Diploid. Flemming. Iodine gentian-violet.

Fig. 35.—Middle prophase: double chromonemata showing intertwining in some of the chromosomic threads; note the amœboid nucleolus.
Tetraploid. Bouin. Iodine gentian-violet.

Fig. 36.—Late prophase: double chromonemata showing inosculations between chromomeric concentrated regions of the chromonemata.
Tetraploid. Bouin. Iodine gentian-violet.

Fig. 37.—Middle prophase: double chromonemata tending to straighten while still very slender and chromomeric.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 38.—Middle prophase: variously looped chromosomic threads showing doubleness almost throughout.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 39.—General aspect of the nucleus in middle prophase: double chromonemata parallel and chromomeric.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 40.—Prophase, a little later than fig. 38: double chromonemata tending to straighten while intertwining with each other; chromomeric structure of the chromonemata vanishing and becoming homogeneous.
Diploid. Flemming. Iron-alum hæmatoxylin.

Figs. 41–43.—Late prophases: uniformly stained double chromonemata showing further intertwining with each other; less chromatic matrix showing increased affinity for stain; note the pointed polar caps in fig. 42.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 44.—Very late prophase: chromonemata have again intertwined and become parallel as chromosomic threads shorten and thicken; note closer association of the chromonemata.
Tetraploid. Merkel. Iodine gentian-violet.

PLATE IV.

Fig. 44A.—Very late prophase: nucleus shows considerable contraction; double chromonemata perfectly parallel and uniformly stained.
Tetraploid. Merkel. Iodine gentian-violet.

Fig. 45.—Very late prophase nucleus: shortened and thickened double chromonemata shaping into fully formed chromosomes; note the attachment constriction in some of the chromosomes; nuclear membrane disappeared; polar caps formed.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 46.—Beginning of metaphase: fully formed chromosomes crowding together in the centre of the spindle; doubleness obscured in some of the chromosomes.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 47.—Further crowding of the chromosomes, doubleness obscured in most of them.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 48.—Chromosomes arranging themselves on the equatorial plate of the spindle; doubleness scarcely discernible.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 49.—Chromosomes are arranged on the equatorial plate; doubleness reappearing.
Diploid. Flemming. Iron-alum hæmatoxylin.

Fig. 50.—Chromosomes of metaphase equatorial plate showing cleavage in each half-chromosome (mother chromonema) with two well-separated daughter chromonemata in each half; matrix biparted.
Tetraploid. Flemming. Iodine gentian-violet.

Fig. 51.—Same as fig. 50, with well-developed chromatic duality in each sister chromosome; chromonemata tending to intertwine with each other after their division; less chromatic matrix forming the ground substance of the sister chromosomes; at *a*, quadruple structure of the chromosome is seen in optical section.
Tetraploid. Flemming. Iodine gentian-violet.

Fig. 52.—Metaphase: chromosomes showing duality in each half-chromosome, especially clear in the chromosomes hanging below.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 53.—Cross-section of two metaphase chromosomes at the equatorial plate, showing four chromatic dots, each a cross-section of a chromonema in the less chromatic matrix.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 54.—Metaphase: chromosomes at the equatorial plate, showing very close intertwining of the daughter chromonemata in each sister chromosome; note the forked ends of the chromonemata.
Tetraploid. Flemming. Iron-alum hæmatoxylin.

Fig. 55.—Metaphase: chromosomes showing already chromomeric structure of the chromonemata.
Tetraploid. Merkel. Iodine gentian-violet.

Figs. 56, 57.—Chromosomes (14) of diploid *Narcissus pseudonarcissus* as they arrange themselves on the equatorial plate. From transverse sections of the root-tip; note that homologous chromosomes are associated in pairs marked with same letters. Fig. 56 shows the chromosomes only in their outline, and in fig. 57 half-chromosomes shown.
Navashin. Iodine gentian-violet.

PLATE V.

Fig. 58.—Homologous pairs of the diploid are shown separately; note the attachment constriction.
Flemming. Iron-alum hæmatoxylin.

Fig. 59.—Chromosomes (28) of the tetraploid "Chinese sacred lily." Homologous pairs are marked with the same letter.
Navashin. Iodine gentian-violet.

Fig. 60.—Chromosomes of the above arranged to show the possible fourfold form of the tetraploid; note the knob and narrow region behind it in most of the chromosomes.

XVII.—THE EFFECTS OF FIXATIVES AND OTHER REAGENTS ON CELL-SIZE AND TISSUE-BULK. 591.1.04

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(From the Department of Physiology, University of Oxford.)

(*Read November* 18, 1931.)

Four Plates.

Introduction and Literature.

This research was undertaken with the aim of studying two of the most important changes produced by fixatives and other reagents on tissues, namely, shrinkage and swelling.

The first to attempt to estimate the degree of shrinkage or swelling of tissues caused by histological reagents appear to have been Kaiserling and Germer in 1893. Ova of the cow and red corpuscles were used as objects. In the case of ova the ripe follicle was incised; the extruded egg cell was then photographed and measured in the follicular fluid. This served as a control. Pressure of the cover-glass and consequent distortion of the ovum were avoided by resting the cover-slip on hairs. After establishing the normal size of the egg cell by the above method, the ovum was washed in 0·675–0·75 p.c. saline, this being regarded by the authors as isotonic. The reason for the treatment with saline was to wash away the proteins in the *liquor folliculi* and hence to avoid the formation of precipitates during fixation.* Various fixatives were then added to the preparation and their effects on the size of the ovum photographically recorded. The chief findings of Kaiserling and Germer were as follows:—

Concentrated mercuric chloride produced marked shrinkage; dilute Flemming's fluid some swelling. Of the fixatives tested, osmic acid appeared to give the minimum of distortion (very slight swelling). According to these authors, ova, once fixed, shrink only to a slight extent during subsequent treatment with alcohol. They state, for instance, that in the case of Flemming fixation, followed by dehydration, the total shrinkage in diameter is 9 p.c. It must be remembered, however, that a reduction in the *diameter* of an egg cell by one-tenth corresponds to a very great reduction in *volume*.

Tellyesniczsy (1926–7) asserts that greater tissue changes occur on transferring a tissue from the fixative to other media than during fixation itself.

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* Comment on this and other previous attempts at determining tissue shrinkage and swelling is deferred till the discussion.

Little change is caused by the fixative once the object has been thoroughly permeated by it.

In 1906 Stöltzner estimated the degree of shrinkage or swelling caused by the fixatives on tissue by a volumetric method based on the Archimedean principle. She calculated the volume of the tissue from the difference between the weight in air and the weight in saline. Various tissues of the rat (liver, kidney, testicle and spleen) were tested, the conclusions to which Stöltzner arrived being as follow:—(1) The volume of the organ is altered by fixation. (2) Different organs give different volumetric response to the same fixative. Thus, a saturated aqueous solution of picric acid shrinks liver but swells kidney, spleen, and brain. Mercuric chloride in a saturated watery solution causes slight swelling, which, however, can be avoided by the addition of a 4·5 p.c. solution of cane sugar to the fixative. This, according to Stöltzner, leaves the volume of the tissue practically unchanged. The after-treatment of tissues (i.e., their reactions to dehydration, clearing and embedding) in respect of the volumetric changes is not considered at all by Stöltzner.

Patten and Philpott (1921) have recently estimated tissue shrinkage in quite a different manner. Working with pig embryos, these authors measured the crown-rump length with micrometer calipers. The control measurements were made in amniotic fluid immediately following excision of the fœtuses. In many instances they also estimated the belly thickness; this they did to make sure that an increase, say, in the latter was not merely compensatory for a decrease in length. In brief, they wished to see whether the shrinkage was general. Conceiving that it was, they therefore ultimately relied on the crown-rump measurement as an index of volumetric change.

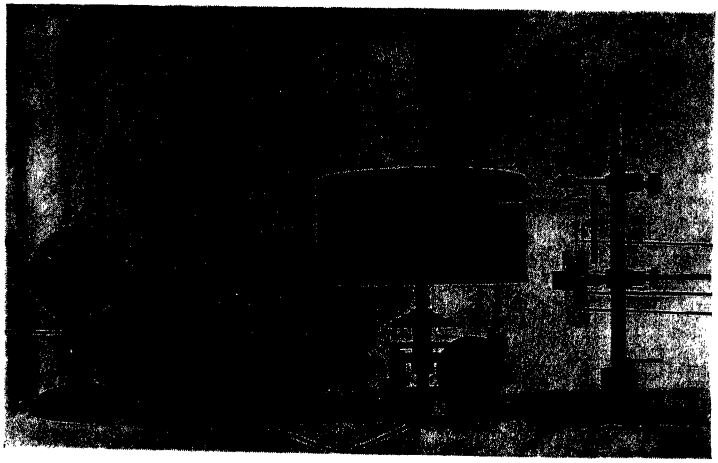
The embryos were measured after treatment in each solution, and were finally embedded in paraffin.

The fixatives tested were those of Bouin, Orth, Tellyesniczsy and Zenker. 10 p.c. formol and formol-alcohol were also used.

Patten and Philpott claimed that the greatest shrinkage (20 to 30 p.c. decrease in crown-rump length) was caused by the fluids containing potassium bichromate, e.g., those of Orth, Zenker, and Tellyesniczsy. Fixation in 10 p.c. formol gave an average increase in crown-rump length of 5 p.c. Formol-alcohol fixation resulted in a slight initial swelling followed by marked shrinkage during dehydration and infiltration with paraffin. Shrinkage in Bouin's fluid was estimated at 2·5 p.c.

The conclusions arrived at by these authors are:—(1) Generally speaking, the greater the shrinkage produced by fixation, the less the subsequent shrinkage during dehydration, and, conversely, a relative lack of shrinkage during fixation is followed by an increased loss of volume during the subsequent dehydration processes. (2) There is an abrupt increase in shrinkage during paraffin infiltration; this is about the same after any fixative.

Donaldson (1894) noted the effects of solutions of potassium bichromate and alcohol on the weight, the volume and percentage of solids in the brain of the sheep, and, in a more general way, on the brain of sharks and man.



gl. c
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t.
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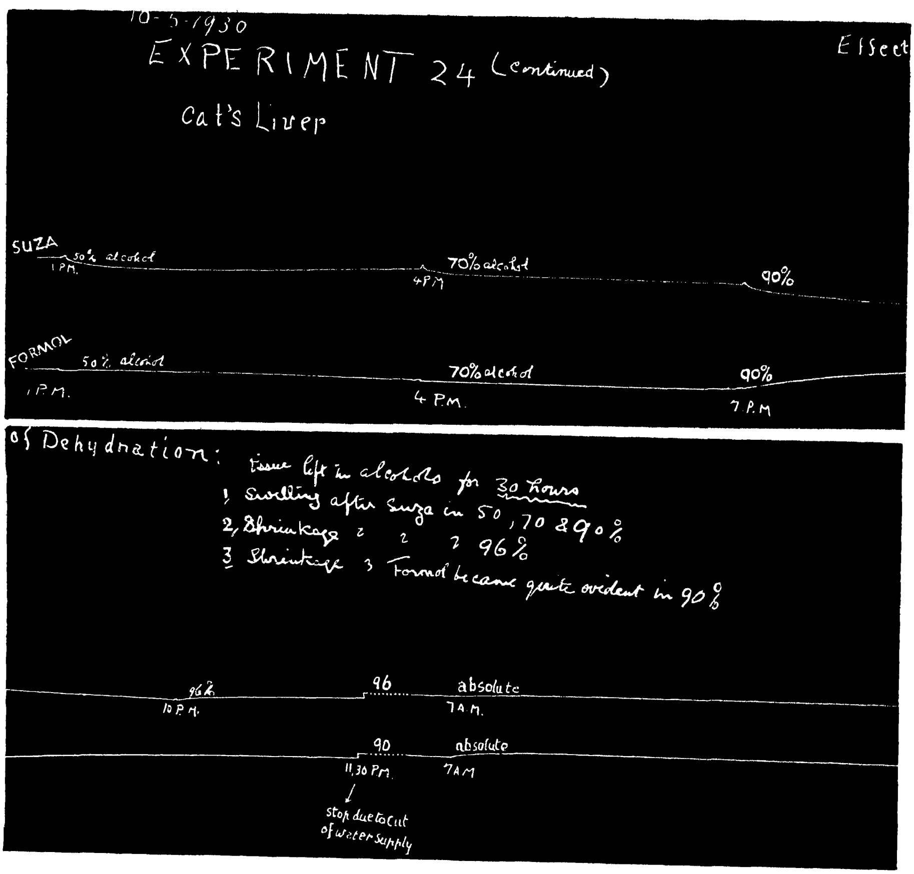
Fig. 1.



10-5-1930
EXPERIMENT 24 (continued)
Cat's Liver
Effect
SUZA
50% alcohol
1 P.M.
70% alcohol
4 P.M.
90%
FORMOL
50% alcohol
1 P.M.
70% alcohol
4 P.M.
90%
7 P.M.
of Dehydration: tissue left in alcohols for 30 hours
1, Swelling after Suza in 50, 70 & 90%
2, Shrinkage " " " 96%
3 Shrinkage " Formol became quite evident in 90%
96%
10 P.M.
96
absolute
7 A.M.
90
absolute
11,30 P.M.
7 A.M.
Stop due to cut of water supply

Fig. 2.

In the case of the sheep the brain was cut longitudinally into equal parts and the hemiencephala were suspended in the hardening fluid for a long period (about two years), during which they were drained and weighed at varying intervals. Donaldson concluded that the sheep's brain in potassium bichromate solutions increases in weight and volume, most of the change occurring during the first 24 hours. After the first two weeks it is comparatively insignificant. The increase of weight is due to taking up of fluid by the specimen. In alcohol there was a decrease of weight and volume, and the higher the percentage of alcohol, the more rapid and greater the loss in weight. The loss in weight is due to decrease in volume of the specimen by shrinkage, extraction of solids, and replacement of water by the alcohol of a lower specific gravity. In the case of 50 p.c. and 60 p.c. alcohol, the decrease in weight is slight and is preceded by an increase. With the shark and human brain similar reactions were obtained. The apparatus and method of finding the volumetric changes are not described, but Donaldson mentions that the curve for volume runs parallel, or nearly so, with that for weight.

Methods and Results.

The methods used in this work are the following :—

(*a*) Graphic registration.
(*b*) Volumetric study.
(*c*) Histological examination.

A great deal of the work here recorded depends on graphic registration. This method proved, after various modifications, to be sufficiently accurate to give a graphic record of the shrinkage or swelling effects produced by the various reagents used in the processes preparatory to section cutting.

The volumetric studies were merely controls to the graphic method.

The histological examinations were likewise complementary; they served also to show microscopically the effects of the reagents on the size of cells and fibres.

(*a*) *Graphic Registration.*

Apparatus.—The apparatus used (*see* fig. 1) was simple; in the course of the experiments it was modified as necessity arose. At first it consisted of a glass tube clamped to a stand. In the tube was placed a syphon for changing the fluids. The piece of tissue was held from above by a hook attached to a thread tied to a lever, and from below by another hook supported on the bent end of a glass cannula.

To show the relative effects of the various reagents, a set of levers of the same length was made. The hanging threads—also of equal length—were tied at equal distances from the fulcrum of the lever.

Fluids were not allowed to touch the thread, in order to exclude all possibility of their being affected, while the needles and hooks were coated

with paraffin wax to protect them from the effects of acids in the fixatives. The pieces of tissue were cut up to the same length and thickness. This is not easy; a Valentine's knife, however, enabled consistently equal slices to be obtained.

The drum was driven by an electric motor, and, by the introduction of a variable double reducing gear, it could be caused to revolve once in 20 to 150 hours as required. During impregnation with paraffin a hot-water bath was put round the glass tube.

The material for these experiments was furnished by the cat, the rabbit, and the *ligamentum nuchæ* of the ox. The latter was chosen because its fibres run in one direction only, so that the effects of fixatives on their transverse and longitudinal diameter could be studied. The tissues examined from the first two animals (viz., the cat and the rabbit) were the liver, spleen, intestine and limb muscles.

The effects of the following pure substances employed as fixatives were studied :—

Alcohol,
Formol,
Potassium bichromate,
Mercuric chloride,
Picric acid,
Chromic acid,
Trichloracetic acid,
Acetic acid.

Also commonly employed mixtures of the above, such as :—

Müller's Fluid	Potassium bichromate	7·5 gms.
	Sodium sulphate	1·0 ,,
	Distilled water	100·0 ,,
Bouin's Fluid	Picric acid (sat. aq. sol.)	75 c.c.
	Formol (40 p.c.)	25 ,,
	Glacial acetic acid	5 ,,
"Susa" (of Martin Heidenhain)	Mercuric chloride (sat. aq. sol.)	50 ,,
	Formol (40 p.c.)	20 ,,
	Glacial acetic acid	4 ,,
	Trichloracetic acid	2 ,,
	Aqua destillata	30 ,,

Dehydration was carried through the commonly used grades of alcohol, viz., 50 p.c., 70 p.c., 90 p.c. and absolute alcohol.

The clearing agents tested were the usual ones, such as xylol, benzol, toluol and cedar-wood oil.

The effects of more than 70 fixations were observed by the graphic registration method, and in about 30 the process was carried on till the end of impregnation with paraffin.

Fixation.—Fixing fluids are here described as simple and compound. By the former is meant a solution of a single chemical in a solvent devoid

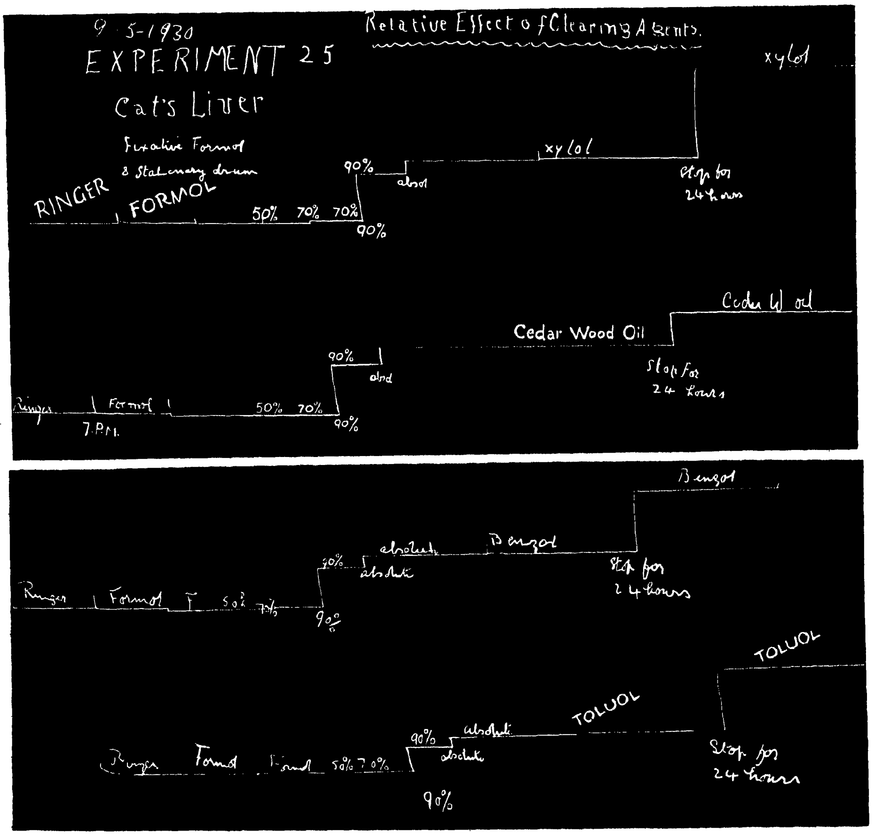

9 5-1930
EXPERIMENT 25
Cat's Liver
Relative Effect of Clearing Agents.
RINGER
FORMOL
50% 70% 70%
90%
xylol
Cedar Wood Oil
Benzol
TOLUOL
TOLUOL
90%

FIG. 8.

of fixing power; by the latter, a fluid containing several substances. Thus, an aqueous solution of potassium bichromate is in the first group, while Bouin's fluid is termed a compound fixative.

Exact comparison of shrinkage is not always obtainable for the following reason—the amount of shrinkage varies according to the histological structure of the piece of tissue. With some fixatives a strong solution will fix and shrink the tissues, while a weaker one may dissociate and swell them; or a fixative may fix certain tissue elements and dissociate the others. But, in spite of the above, a fairly satisfactory idea of their relative effects has been obtained.

Single reagents used as fixatives by themselves or as ingredients of fixing mixtures may be thus tabulated:—

Reagents Producing Shrinkage.	*Reagents Producing Swelling.*	
Absolute alcohol.	Acetic acid.	
Picric acid (sat. aq. sol.).	Trichloracetic acid.	
Mercuric chloride (sat. aq sol.).	Picric acid	in weak solutions.
Chromic acid.	Potassium bichromate	in weak solutions.
Potassium bichromate.	Chromic acid	in weak solutions.
Formol.		

The method of graphic registration of the action of certain fixatives makes evident some of the following effects:—

The absolute alcohol curve is the highest. Absolute alcohol is a powerful shrinking agent, perhaps the most powerful of the simple fixatives. It hardens tissues by coagulation of their proteins and withdrawal of water. Its shrinking power is evidently due to the fact that it acts both as a fixative and as a brutal dehydrating agent. Connective tissue fibres lose in width and shrink more in it than other tissues. Most of the shrinkage takes place in the first two or three hours, and gradually decreases during the process of fixation.

Strong aqueous solutions of chromic acid (1 p.c.) and potassium bichromate (4 p.c.) have only a slight shrinking effect; dilute solutions of the above, when used at the concentrations often employed for dissociation (0·02 p.c. and 0·02 to 1·0 p.c. respectively) produce swelling.

Picric acid in concentrated aqueous solutions shrinks glandular tissue, such as the liver, during fixation, but is liable to swell and dissociate ligament and tendon.

Mercuric chloride considerably shrinks both cellular and fibrous tissues; since it usually penetrates slowly, the shrinkage continues over a long period.

The effects of formol at standard concentrations (5–10 p.c.)* are of interest. In the majority of the experiments it caused no shrinkage at all. Occasionally

* The percentage of formol solutions is reckoned throughout this paper in terms of the percentage of formaldehyde, this being the only way in which confusion as to the degree of dilution can be avoided.

a very slight contraction was noted, but never any swelling. Tissues after being taken from it are slightly toughened, but retain a good deal of their natural elastic consistency. In mixtures, formol tends to augment the shrinking power of other ingredients apparently by increasing their power of penetration.

Acetic acid is an energetic reagent that swells the tissues tremendously; when used by itself it also gelatinizes the collagenous fibres. Tissues fixed in acetic acid or in mixtures containing it swell on being put into water, especially connective tissues.

Trichloracetic acid has a much milder effect. It swells tissues to a certain extent, after which they become somewhat tough and shrink slightly. Connective tissue fibres, while swelling transversely, compensate for this by some longitudinal shrinkage. This was clearly shown by placing pieces of the *ligamentum nuchæ* of the ox in the apparatus so that the fibres were either longitudinally or transversely orientated. Bouin's and Müller's fluids were sometimes found productive of slight shrinkage.

In many of the experiments it was noted, when changing the fluid and thus exposing the tissues, that the lever recorded a definite shrinkage—the effect of drying on the superficial layers of the tissue. This clearly indicates the harmfulness of leaving pieces of tissues "high and dry" while reagents are being changed. This shrinkage is most marked in the case of fresh tissues before fixation. In my observations the base line was obtained with the object in normal saline, withdrawal of this and exposure of the tissue causing definite shrinkage.

Dehydration.—As is well known, tissues shrink on withdrawal of water from them. The observations here recorded show that, if tissues are considerably shrunken by the fixative, little shrinkage is induced by dehydration, and *vice versa*. There is usually only slight shrinkage in the lower grades of alcohol, such as 50 and 70 p.c. Active shrinkage occurs in 90 p.c., 96 p.c., and absolute alcohol, and in all of them most of the shrinkage takes place at the beginning of immersion in the higher grade.

After acetic acid fixation, or fixatives containing acetic acid, like "Susa," lower grades of alcohol are liable to swell the tissues.

Fig. 2 shows two dehydration curves, one after 5 p.c. formol fixation and the other after "Susa" (cat's liver being the tissue used).

After formol there is practically no shrinkage in 50 p.c. and in 70 p.c. alcohol; preservation of tissues in the latter grade of alcohol finds justification here. In 90 p.c. and in absolute alcohol marked shrinkage occurs.

After "Susa" there is a very slight swelling on the addition of 50 p.c. alcohol, the tissue continuing to swell in 70 p.c. and 90 p.c. alcohol also. But on changing the 90 p.c. for 96 p.c. alcohol, the curve begins to rise, the tissue contracting also in absolute alcohol. This shrinkage that takes place in 96 p.c. and absolute alcohol compensates for the swelling in the lower grades of alcohol.

Clearing and Embedding.—The effect of clearing after two different

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

fixatives, "Susa" and formol, was noted. One fact emerged: it was the progressive nature of the shrinkage during clearing.

Fig. 3 is a diagram of four records showing the relative effects of some of the common clearing agents, viz., xylol, benzol, toluol and cedar-wood oil. The tissue used was the cat's liver, pieces of which, 4·5 cm. in length and 2 mm. in thickness, were fixed in 5 p.c. formol-saline for 24 hours, and finally left in the clearing fluids for 24 hours.

In formol and in 50 p.c. alcohol no shrinkage at all was recorded. In 70 p.c. alcohol there was shrinkage in two experiments out of four. In 90 p.c. and in absolute alcohol marked shrinkage occurred in all the four experiments.

During clearing, a further very considerable shrinkage is seen to occur. From this and the other experiments the shrinking power of the four commonly used clearing media may be expressed thus:—

Xylol (maximum shrinkage).
Toluol.
Benzol.
Cedar-wood oil (minimum shrinkage).

Even oil of cedar is productive of quite appreciable shrinkage, but it is far less than with the other media. Cedar oil also has the advantage of leaving tissues relatively elastic in contrast with the hardening action of xylol.

In some of the experiments the effect of raising the temperature of the clearing fluid by putting a hot-water bath around the glass tube was noted. Shrinkage was found to begin and to continue as the temperature was raised to the limits recorded in these experiments (*circa* 60° C.).

In order to get some idea of the effect of paraffin apart from the factor of heat, impregnation of tissues with medicinal paraffin (B.P.) was attempted. This is miscible with xylol and penetrates easily. Tissues contracted in it, and the longer they were left, the more they contracted. This shows that, besides the heat factor, paraffin itself has the power of shrinking tissues to some extent.

(*b*) *Volumetric Studies.*

Apparatus.—The apparatus consisted of a bottle with two tubes passing through the stopper. The short tube served to fill the bottle and passed down it so as to be immersed beneath the surface of the fluid, the aim of this being to secure easy expulsion of any air. The other tube was a long capillary, and served to measure shrinkage or swelling.

During fixation, changes coinciding to those recorded by the graphic method have been observed in the various fixatives, such as mercuric chloride, absolute alcohol, and formol. In others, however, shrinkage was not noticeable, and its relative degree in the various fixatives, especially in the compound fluids, was variable. The method, however, is greatly inferior

to that of graphic registration. The results are influenced by changes in the temperature of the room. The estimation of shrinkage during dehydration is further vitiated by the fact that alcohol and water contract on mixing. The method is also open to criticism on the following grounds: the volume of the reagent surrounding the tissue may remain the same even when the latter has changed in volume. Thus the block of tissue, when shrinking, may give up fluid to the surrounding medium. Little or no change may then be recorded. Inversely, swelling of the tissue may be compensated for by the subtraction of surrounding fluid. Still, some confirmatory evidence of the graphic registration method was obtained.

(c) *Histological Examination.*

The objects used were the duodenum and liver of the cat. Liver was chosen as an example of glandular tissue; duodenum seemed indicated because it enabled changes to be noted in three different types of tissue, viz., epithelial, connective, and muscular.

Fig. 4 is a photograph of a hepatic lobule from a specimen fixed in 5 p.c. acetic acid, then dehydrated, cleared and embedded in paraffin. The very wide calibre of the intralobular veins is noticeable. The supporting reticulum of the hepatic cells and the connective tissue of the portal sheaths are destroyed. In the case of the hepatic cells both the cell-boundaries and the cytoplasmic components have been dissolved and destroyed. Such cells that have partially escaped destruction are extraordinarily swollen. The nuclei themselves are prominent and are relatively unaffected. These microscopic changes have their naked eye counterpart: the swelling is obvious, and the tissue remains soft.

Fig. 5 is of a section of liver fixed in 5 p.c. trichloracetic acid. The effect is partly similar to that of acetic acid, but far less destructive. Although swelling the tissue, it fixes thoroughly at the same time. The hepatic cells are definitely swollen; their nuclei stand out sharply, and the radiating arrangement of the cells of the lobules is retained.

Fig. 6 shows the effect of fixation in a concentrated aqueous solution of mercuric chloride. When compared with the two preceding figures, the great difference in the size of the cells is obvious. Figs. 4, 5 and 6 were photographed at the same magnification. The cells are extremely shrunken, so likewise is the tissue of the portal sheaths.

Absolute alcohol causes marked shrinkage; the superficial layers are especially affected, the connective tissue tending to shrink more than the hepatic cells.

Fixing fluids often contain ingredients augmenting or opposing the effect of each other, and the effect then produced varies according to the relative action of each component. Thus, pieces of the abdominal wall of the cat, containing skin, fascia and muscle, when fixed in corrosive-acetic (5 p.c. acetic acid in saturated aqueous solution of mercuric chloride) show

tremendous swelling, which is particularly noticeable in the fascia. The naked eye bulk is, in fact, about double what it was before fixation.

Fig. 7 depicts the effects produced by fixation of liver in corrosive-acetic; it shows the œdematous-like swelling of the portal tracts; the liver cells themselves are less affected. The acetic acid increases the penetrating power of corrosive sublimate, while the mercuric chloride impedes the destructive action of acetic acid on the cells; nevertheless, the acetic acid seems unduly to swell the connective tissue, particularly if the duration of fixation be excessively prolonged.

In "Susa" the formol and mercuric chloride work together to counteract the action of the swelling ingredients trichloracetic and acetic acids.

It is generally stated (Heidenhain, 3, 4 and 5) that tissues fixed in "Susa" or trichloracetic acid swell when put into water or lower grades of alcohol, and hence must be transferred directly from the fixative to 96 p.c. alcohol. Careful microscopic examination of "Susa"-fixed material passed to water, and of the same passed directly to 96 p.c. alcohol, has shown me that the amount of swelling produced by water and the lower grades of alcohol is insignificant. The graphic method confirms this; the slight swelling produced by water is compensated for by the shrinkage in the higher grades of alcohol and in the clearing medium. Direct transference, however, of tissues from "Susa" to 96 p.c. alcohol is to be recommended, as it spares the tissue unnecessary changes and saves time.

The swelling which is produced by water or lower grades of alcohol after trichloracetic acid fixation is more marked than after "Susa" fixation. It seems, therefore, that it is the formol and the mercuric chloride of "Susa" which make the tissue resistant to swelling.

The following table gives the average thickness of the submucosa of the cat's duodenum after treatment with various fixatives. The pieces were adjacent and taken from the same duodenum. To compare the effects of transferring material fixed in "Susa" and trichloracetic acid to 96 p.c. alcohol to those of putting it into water (or lower grades of alcohol), the following method was used. A piece of tissue, after fixation, is bisected with a sharp razor; one-half is put into 96 p.c. alcohol, the other into water. Sections are made from the surfaces that were facing one another and hence are practically from the same spot.

Fixative Used.	*Average Thickness of the Submucosa in Microns.*
Absolute alcohol	465
Mercuric chloride	620
"Susa" (followed by 96 p.c. alcohol)	775
"Susa" (followed by water)	775
Trichloracetic acid (followed by 96 p.c. alcohol)	920
Trichloracetic acid (followed by water)	970
Corrosive-acetic	1,007

Figs. 8, 9 and 10 were photographed after fixation of duodenum in absolute alcohol, mercuric chloride, and trichloracetic acid respectively; they demonstrate the relative effects of each on the submucosous tissue.

Discussion.

The literature on the subject of tissue shrinkage is scanty, and many of the methods used have had defects that have frequently been the cause of indefinite or contradictory results. Stöltzner, for instance, while estimating the degree of shrinkage or swelling by a volumetric method, used to dry the objects, before weighing them, in the air. Such drying probably affects deeper structures and damages the tissues. Immediately a piece of tissue (as shown by my experiments) is exposed, air progressively dries the superficial layers, and shrinkage sets in. This shows that all changes of reagent should be rapidly made. In the case of unfixed tissues, the shrinkage effect of exposure is particularly marked; organs should be immediately placed in the fixative after excision, and not left lying on the post-mortem table or on the laboratory bench. Failing this, they should be wrapped in gauze soaked in normal saline or in Ringer-Locke solution, and kept in a closed vessel in the ice chest.

Stöltzner claims that mercuric chloride in aqueous saturated solutions causes slight swelling, and advises the addition of a 4·5 p.c. solution of cane sugar to the fixative. In all the experiments in which I used saturated mercuric chloride alone, I found shrinkage both by the graphic registration method and on microscopic examination. From her advice regarding the addition of cane sugar, Stöltnzer seems to have regarded a saturated solution of mercuric chloride as hypotonic. In point of fact, such a solution is already strongly hypertonic, and the addition of cane sugar *merely* increases its hypertonicity. In brief, the factor of drying would seem to vitiate Stöltzner's volumetric conclusions.

Patten and Philpott found that formol swelled the tissues, and that fixation of their pig embryos in 10 p.c. formol resulted in an average increase of 5 p.c. in the crown-rump length. It is difficult to reconcile their results with those recorded here. The discrepancy may be accounted for by one or more of the following considerations. Patten and Philpott refer to their concentration of formol as being 10 p.c. Unfortunately, there are two ways, both in current use, of estimating the strength of a formol solution. The first (and undoubtedly the correct manner) is always to refer to the concentration in terms of formaldehyde. The other is to ignore the fact that commercial formol is a 40 p.c. solution and to dilute it as if it were a 100 p.c. solution. If Patten and Philpott worked on this assumption, then the real concentration, in terms of formaldehyde, would be nearer 4 p.c. than 10 p.c., and unless large volumes of the fixative were used, or the fluid changed, yet further dilution of the fixative by the tissue fluids might occur. Dilute solutions of formol are generally admitted by histologists to produce swelling, and this may be the explanation of this phenomenon in the experiments of the American authors. The use of calipers is also a relatively gross method of estimating volume changes, although Patten and Philpott did try to allow for the possibility of decrease in length being accompanied by increase in girth by measurement of the belly thickness.

FIG. 8.

FIG. 9.

FIG. 10.

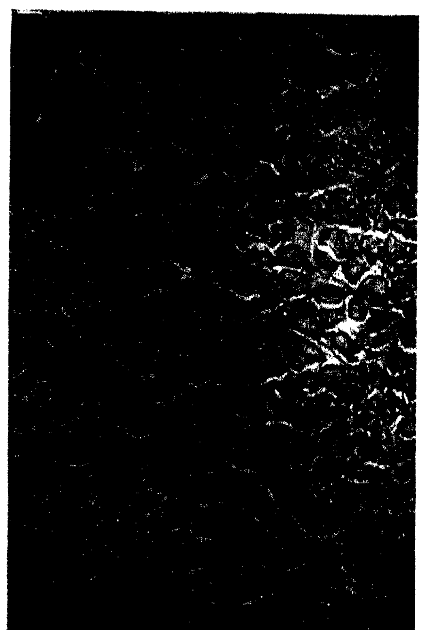


FIG. 11.

Under the conditions of my experiments it was found that formol, in concentrations varying from 5 to 10 p.c., was not once productive of swelling. Usually both the graphic registration and the volumetric methods revealed a very slight tendency to shrinkage.

Acetic acid, as pointed out by Gatenby, is a dangerous reagent. It is useful in counteracting the shrinking action of other ingredients combined with it, but if the action is prolonged, it swells and gelatinizes the tissues; hence organs fixed in it should not be treated for a longer time than is necessary. Lower percentages (1–2 p.c.) are safer to use, and still safer and more preferable is the use of trichloracetic acid instead. Both acetic and trichloracetic acids clarify the tissues, and seem thereby to add to their optical differentiation.

Dehydration, from the indications of my experiments, is a process which should be gradual. No matter, generally speaking, what fixative has been used, the degree of shrinkage in the lower grades of alcohol (50 and 70 p.c.) is negligible, most of it occurring during treatment with 90 p.c. and absolute alcohol.

My results tally with those of Patten and Philpott in that there is a general tendency for the shrinkage in dehydration to be greater when the shrinkage in the fixative is less. It looks as if tissues possessed a more or less limited power of shrinkage, which, if exhausted in the fixative, can not manifest itself to the same extent during dehydration, and *vice versa*.

This does not seem, however, to be the case with the clearing media. Thus, xylol causes yet further shrinkage. The longer the tissue is left in a clearing medium, the more it shrinks. Even in cedar oil, which causes the least distortion of the four media tested, slight shrinkage is recorded. Further, the shrinking action of clearing media is slow and progressive over long periods. This indicates that tissues should be left in clearing fluids for the shortest time consistent with substitution of the medium for the alcohol. Xylol renders the material brittle, and cedar-wood oil, though productive of some shrinkage, yet preserves the elasticity of the tissues. Pure benzol causes far less shrinkage than xylol, and penetrates rapidly. For routine work it is probably one of the best general clearing reagents.

During embedding there are two factors working together and causing shrinkage: paraffin and heat. The shrinkage caused by the paraffin is apparently very slight. The heat effect is definitely deteriorating, and if prolonged, or if the temperature be unduly raised, is liable to shrink greatly or even ruin delicate structures.

An attempt was made to avoid the shrinkage produced by the heat of the paraffin thermostat. A piece of formol-fixed spleen was dehydrated and cleared in the ordinary manner. It was transferred to medicinal liquid paraffin (B.P.). After one day's impregnation in this at room temperature, it was directly embedded in hard paraffin wax without putting it in the thermostat. It was possible in this way to obtain sections which showed no apparent shrinkage on examination with the microscope. The method has one

disadvantage in that the liquid paraffin in the piece of tissue is not hard enough to support the section; ribbon-formation is, hence, difficult.

Facts which receive strong support from the application of the graphic registration method during embedding—supplemented by microscopic observations—are the following:—

The temperature of the thermostat should never be more than 2 or 3 degrees above the melting-point of the paraffin wax. The softer the latter—consistent with its giving sufficient support to the tissues—the better, as the temperature of the embedding bath may thereby be kept down. Since, as in clearing, the shrinkage of tissues during embedding is slow and progressive, the duration of the embedding bath should be curtailed to the necessary minimum. With experience it is possible to clear and embed tissues in a far shorter time than is generally reckoned necessary.

Clearing and embedding must, in fact, be regarded as harmful but necessary procedures, the action of which should be inflicted upon tissues for the shortest possible time consistent with proper penetration.

It is a pleasure to record my appreciation of the facilities afforded me by Sir Charles Sherrington, in whose department this work was done. To Dr. H. M. Carleton I have to acknowledge my indebtedness for his help and advice.

Summary.

A simple method of graphic registration, supplemented by microscopical observations, has led to the following conclusions:—

(1) Exposure of fresh organs and tissues to air produces shrinkage. As soon as excised, they should be placed in the fixative. When this is not possible, the tissue should be wrapped in gauze wrung out of normal saline, and kept in a closed vessel at a low temperature (preferably a few degrees above freezing).

A similar, though less marked, shrinkage effect occurs when tissues are exposed to the air between the different grades of alcohol. This shrinkage is ascribable to the drying effect of the atmosphere on the superficial layers of the tissues.

(2) Formol, in concentrations of 5 to 10 p.c. over periods of 24 to 48 hours, does not swell tissues. By the graphic registration method a very slight shrinkage is occasionally recorded; the degree of shrinkage in any case is so small that it is not apparent with the microscope. The use of formol for periods longer than 2 or 3 days should, generally speaking, be avoided, on account of its distinct toughening effect on tissues and the consequent difficulty in sectioning.

(3) Mercuric chloride and picric acid (in saturated aqueous solutions) are powerful shrinking agents; so is absolute alcohol. Strong solutions of chromic acid (1 p.c.) and potassium bichromate (4 p.c.) are similar in effect.

(4) Acetic and trichloracetic acids swell cells and collagen fibres if used

alone. Tissues, when placed in water directly after these fixatives, swell unduly ; hence transference direct to 96 p.c. alcohol is always indicated after fixation in these fluids.

(5) The direct transference of material fixed in "Susa" to a lower (50 p.c.) grade of alcohol does not seem to be productive of the harmful swelling usually ascribed to this procedure. Such swelling does occur, but is very slight, and is amply counteracted by the slight shrinkage caused by the subsequent treatment in the higher grades (96 p.c. and 100 p.c. of alcohol).

(6) The capacity for shrinkage of tissues appears to be limited. Thus, as already pointed out by Patten and Philpott (1921), tissues treated with fixatives that produce but little shrinkage are all the more liable to shrinkage during dehydration, and *vice versa*.

(7) Clearing is productive of a slow and progressive shrinkage. This deleterious effect appears to be largely independent of the fixative originally employed. Some clearing media shrink more than others. Xylol and toluol shrink tissues more than benzol, while oil of cedar (as is generally accepted) produces the least shrinkage of the four. Benzol penetrates rapidly, is relatively cheap, and is quickly eliminated during embedding.

(8) Paraffin embedding should be cut down to the shortest time consistent with penetration. Paraffin causes progressive shrinkage, an effect which is largely in direct proportion to the temperature. Hence the lower the temperature of the thermostat, the less are the tissues injured.

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EXPLANATION OF PLATES.

Fig. 1.—gl. c., glass cannula; gl. t., glass tube; t., piece of tissue; m., electric motor; r.g., double reducing gears.

Fig. 2.—Effects of dehydration on liver.

Fig. 3.—Relative effects of xylol, toluol, benzol and cedar-wood oil on liver.

Fig. 4.—i.v., intralobular vein; n., nuclei.

Fig. 5.—p.t., portal tract; c., hepatic cells; n., nuclei.

Fig. 6.—c.c., columns of liver cells; p.t., part of a portal tract.

Fig. 7.—h.t., liver tissue; b.d., bile duct; p.v., branch of portal vein; s.c., swollen connective tissue of portal tract.

Fig. 8.—cr. l., crypts of Lieberkühn; sb.m., submucosa with Brunner's glands; c.m., circular muscle layer.

Fig. 9.—m.m., mucous membrane; sb.m., submucosa layer; c.m., circular muscle layer.

Fig. 10.—m.m., mucous membrane; sb.m., submucosa.

Fig. 11.—Transverse section of *ligamentum nuchæ* to show that its fibres all run in the same direction.

XVIII.—NOTE ON PICRO-CONGO-RED STAINING. **535.826.**

By G. P. Gnanamuthu, M.A., F.Z.S.

(*Read May* 20, 1931.)

In studying the anatomy of the intrinsic muscles of the tongue of various Reptilia, the author of the present note had to take sections of entire tongues. As in such preparations he had to distinguish between a variety of tissues, such as muscles, fibrous tissues, tendons, ligaments, bone, cartilage, blood-vessels, and nerves, he had to look for a simple staining mixture which will act quickly, selectively, and which will suit the more common fixatives. As he preferred for his materials Bouin's Picro-formol to any of Flemming's fixing fluids, he has found a mixture of picric acid and Congo-red giving good results when combined with Ehrlich's hæmatoxylin.

Picro-Congo-Red.—12·5 c.c. of saturated solution of picric acid was taken, and about an equal volume of ammonia was added and thoroughly shaken up. About 0·60 gr. of Congo-red (Grubler's) was dissolved, and the excess of ammonia boiled off. After allowing the solution to stand, a sediment was formed, and distilled water was added to make it dissolve. The ammonia was added to provide an alkaline medium for the solution of Congo-red in picric acid.

Staining Method.—The sections are washed in 70 p.c. alcohol and kept in Ehrlich's hæmatoxylin for a period of 5 minutes or a little less, washed in alcohol, and taken into water. The sections are then stained with the Picro-Congo-red for from 1 to 2 minutes and washed in water. They are dehydrated with alcohol, cleared in xylol, and mounted in balsam. As the stain acts very quickly, the exact degree of shade should be adjusted under the microscope.

Sections so stained will show that the hæmatoxylin differentiates the tendon, the fasciæ of muscles, glands, cartilage, nerves, and the nucleus of blood corpuscles, while the Picro-Congo-red stains the muscles, articular or transitional cartilage, and the cytoplasm of blood corpuscles. As in the tongue the former tissues are scattered among and around the muscles which form the chief part of the tongue, this stain proves very useful.

The proportion of picric acid and Congo-red may be altered with advantage, and the whole technique adjusted to suit other requirements.

Gentian-violet appears too strong for a primary stain, and Erlich's hæmatoxylin is to be preferred. Previous to devising this mixture, the author stained the sections with alcoholic borax-carmine, followed by Picro-Indigo-Carmine (Ramon y Cajal), and found the first stain a trifle too slow and weak, only the glands showing an affinity, and the second stain colours all the rest of the tissues.

My thanks are due to Mr. R. V. Subramanian, Professor of Chemistry, American College, Madura, for many helpful suggestions.

XIX.—SOME EARLY ACHROMATIC MICROSCOPES: FRAUNHOFER'S MICROSCOPES. 535. 822.

By Reginald S. Clay, D.Sc., and Thomas H. Court.

(*Read October* 21, 1931.)

One Text-Figure.

Application of Achromatism to the Microscope.

The description before the Royal Society in June, 1758, of the invention of the achromatic telescope would naturally suggest the application of achromatism to the microscope, and probably more than one attempted the task.

In 1759 Benjamin Martin, in his "New Elements of Optics," after dealing with the telescope, goes on to say (p. 96): "Having found so great a difference in the appearance in the solar focus of a compound (i.e., achromatic) lens and speculum, I thought it would be necessary to compare the image formed in the proper or conjugate focus of a small triple (i.e., achromatic) lens and speculum applied as an object-glass in a compound microscope . . . which I did by giving the same length to the images and viewing them with the same eye-glasses, and, consequently, the small objects were equally magnified in the reflecting and refracting microscopes, but that with how great a difference in point of clearness and perfection, in all the circumstances of vision, those only will be able to conceive who shall try the experiment themselves." He says he made a similar comparison between the double achromatic lens and a speculum with the same focal differences applied to a camera obscura and also to a solar megaloscope. In every instance the speculum was the clearer. It is evident, therefore, that Martin not only made an achromatic objective for a microscope, but he tested it and published the results of his experiments. As he was satisfied there was no improvement on the simple lens, he did not pursue the subject.

We know, from an entry in Gill's Technical Repository, that I. Kimbal, who afterwards, at 23, Dean Street, ground lenses for Carpenter and others, had been apprenticed to Martin, and during his apprenticeship was the actual maker of these achromatic objectives.

In the life of James Watt there is a letter from a Dr. Small to Watt, in which Small says: "I am attempting the improvement of the telescope and, still more anxiously, of microscopes, because the present microscopes

deceive their users; but I find it very difficult to procure good lenses. Could you make an achromatic lens of half an inch focal distance? Dollond's patent is out."

When it is remembered that the components of an achromatic lens must have much higher curvatures than those of a simple lens of the same power, and that the use of Canada balsam to cement the lenses together was not invented by the Abbé Rochon until 1793, it will be seen that the lenses would have to be ground to a higher order of precision to obtain images equally clear. Of still greater importance would be the greater spherical aberrations that were produced by the use of higher curvatures, which they did not know how to manipulate. Martin gives no data of the curves to which he ground the lenses, or the way the combination was built up, so we can carry the criticism no further; but it is very probable that he would have used a biconvex lens as one of the components, which would have had a large amount of spherical aberration.

The mathematician Euler was said by some to have devised an achromatic lens before Dollond; but this was clearly an error (*see* "The Life of John Dollond," by John Kelly, 1808, pp. 65–74). At a later date (1774) Nicolas Fuss, in a paper, "Instruction détailée pour porter les lunettes au plus haut degré de perfection, avec la description d'un microscope qui peut passer pour le plus parfait dans son espèce" (St. Petersbourg, 1774), gave instructions for the manufacture of an achromatic objective for the microscope with the curvatures of the surfaces; the lens was composed of two biconvex crown lenses with a biconcave flint lens between them. The focal length was to be ½ inch. According to Harting, a lens of this form was made by Herr G. J. Beeldsnyder, of Voshol, of which Harting believed he had found an example; this lens had a combined focal length of 21 mm. He says it gave a "clear and sharp image." ("Das Mikroskop," 1859, p. 691.)

Some years later Charles, in Paris, made some achromatic lenses. These were preserved in the Conservatoire des Arts et Métiers; but according to Chevalier (Dict. Micros., p. 51), their curvatures and centering were so defective that they were quite useless.

In "Natuurkundige verhandelingen van de Koninglyke maatschappy der wetenschapen te Haarlem" (Amsterdam, 1807, iii, p. 2), Herman van Deyl described the construction of an achromatic microscope. Harting found one of his microscopes in the physical cabinet at Utrecht. He says there were two achromatic objectives. One had a focal length of 18 mm. and an angular aperture of 14°, and the other had a focal length of 13 mm. and an aperture of 15°. The lens in each case was composed of a biconvex crown and a biconcave flint, the flint lens being the nearer the object and having its outer surface nearly flat. He says that, with an ocular that gave a total magnification of about 90, he could resolve the first group of a Nobert test plate (443 lines to the millimetre), which he could only do with three times as great a magnification with a non-achromatic lens.

FRAUNHOFER MICROSCOPES.

Fraunhofer, in Munich, advertised an achromatic microscope in his catalogue of 1811 (Gilbert's Annal., vol. 38, p. 347). This was a drum microscope, which form was first made by Benjamin Martin in 1738. Fraunhofer would thus seem to have been the first to have made an achromatic microscope as an article of commerce, although Mayall (Cantor Lectures, R.S. Arts, 1886, p. 1072) says he does not appear to have been satisfied with them.

In 1816 he published a catalogue (Joseph Fraunhofers Leben, Leistungen und Wirksamkeit, M. v. Rohr, Leipzig, 1929, p. 184) containing an account

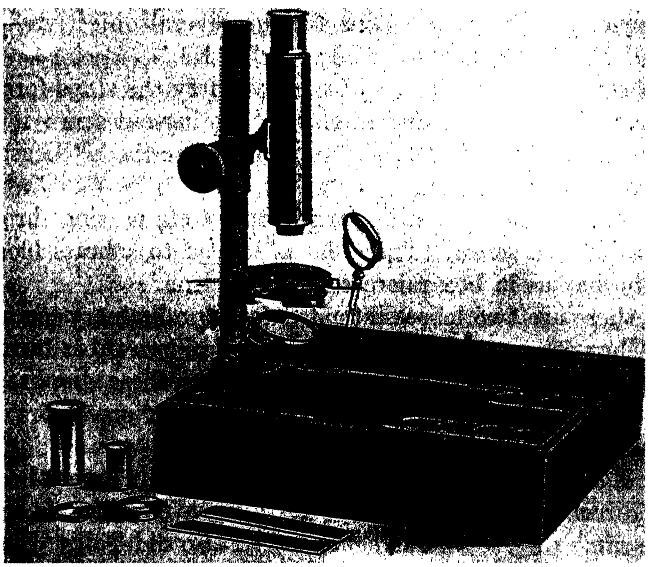


FIG. 1.

of a "compound microscope with complete apparatus . . . with illuminating apparatus, six achromatic objectives, a double and a single ocular of different fields and magnifications. The magnifications are 16, 21, 32, 53, 74, 100 with the single ocular, and 24, 31·5, 48, 79·5, 111, 151 with the double ocular. The whole microscope is in a polished case," and the price is 1,010 silver marks.

This same microscope is again advertised in his catalogues of 1820 and 1826.

In the same catalogues is advertised a smaller compound microscope with four achromatic objectives giving magnifications of 20, 30, 50, 75, and 110. This had two oculars, and in its case cost 253 S.M. Von Rohr says this is the microscope No. 55 in the Zeis Museum at Jena. This appears to be the microscope shown in the photograph fig. 1 from the Court collection. The

two oculars are peculiar in that they have a common field lens—a plano-convex lens of about 2 inches focal length—and only the eye lens is exchanged. The eye-lens marked "A" is a plano-convex lens of about ½ inch focal length; the other, marked "B," is composed of two plano-convex lenses mounted with their curved surfaces facing one another. The upper has a focal length of about ⅝ inch, and the lower about an inch.

The objectives are numbered	1	2	3	4	
Their initial magnifications are	2	5	7	10	approximately.
Their numerical apertures are	·03	·06	·08	·10	approximately.

The body is traversed on the pillar by a rack, and the pillar is inscribed to give the approximate focal positions for the several objectives—on one side A1, A2, A3, A4, and on the other B1, B2, B3, B4.

The stage is circular, with two projections to carry the stage forceps and stage condenser, which is hinged and carried on a swing-out arm; it also has a spring-ring below it to take the sliders. It is inscribed "Utzschneider und Fraunhofer in Bendictbeurn."

The mirror is concave only, and is carried on a stem passing through the pillar and clamped by a screw. The pillar is hinged to a brass block fixed to the end of the box as in box microscopes of Nairne.

In the case there are two lenses intended for a preliminary examination of the object. They are mounted at the lower ends of two tubes furnished at the tops with diaphragms, and of such lengths that these diaphragms are about in the upper focal planes of the lenses, which are approximately 1 inch and 2 inches in focal length respectively.

As the rack is on the back of the pillar, the coarse adjustment head turns in the opposite direction to the usual way. Swift made one once, as an experiment, with the same reversed movement, and so also did Tollis. The sleeve is sprung, and there is a pair of screws which draw the edges together tangentially to tighten the sleeve on the pillar.

The workmanship is good, and an examination of the achromatic lenses shows that they compare very favourably with those of Chevalier and Pritchard of a much later date.

In the Science Museum there is a cheaper form of this microscope, apparently the one advertised in the catalogues of 1820 and 1826 at a price of 119 S.M. This has no rack, the tube merely sliding in a sleeve. It has three achromatic objectives and only one ocular. The magnifications are given in the catalogue as 20, 30, and 50. It is mounted rigidly on a box foot, otherwise it is very similar to the one already described, with the same stage, stage-condenser, mirror, and concave glass for liquids.

In 1829 two important improvements in the achromatic microscope are described in "Nachricht von einem verbesserten aplanatischen Mikroskop aus dem optischen Institut Utschneider und Fraunhofer zu München." In this pamphlet objectives are described which are made to screw into one

another, so that one, two, three, or even four objectives can be used in combination. A table is given (p. 17) showing magnifications varying from 12, with the weakest objective and the lowest-power ocular, up to 1,000, with a combination of the three highest-power objectives and the highest-power ocular. George Adams had combined two or more non-achromatic lenses in the same way at least 50 years before this.

Charles Chevalier (" Notes Justificatives ") says that, in 1823-4, Messrs. Vincent and Charles Chevalier had made a microscope for Seligue which had four achromatic doublet lenses which screwed together, and that it was exhibited at the Académie des Sciences. In 1824-5 Chevalier made a microscope, " Selon Euler," and exhibited it at the Société d'Encouragement; this microscope, however, had single achromatic lenses. In 1827 Amici exhibited his horizontal achromatic microscope in Paris, which had two superposed achromatic lenses; these had longer focal lengths than Chevalier's. In the same year Chevalier made a microscope to Amici's design and exhibited it at the Louvre. Thus Seligue was apparently the first to adopt, in 1823, for the achromatic objective, a combination of two or more achromatic lenses to form a compound lens six years before the microscope described in Fraunhofer's pamphlet of 1829, and four years before Amici used it. This construction was continued in the well-known French " button" lenses made by Chevalier and others, which were so commonly supplied on the cheaper microscopes, and, indeed, are still supplied to the present day.

The other new feature introduced in the microscopes described in Fraunhofer's pamphlet is the reflecting right-angle prism, intended to make observation through a microscope less tiring through changing the direction of the beam from vertical to horizontal. This construction had been introduced by Amici in 1827 (Dinglers Polytechnischem Journal, B. xxxii, H. 4), and was largely adopted upon the Continent by Oberhäuser, Merz, Chevalier, Plössl, and others. We have seen a microscope by Powell and Lealand with such a prism, but it never found much favour in England.

There is in the Science Museum a microscope which closely resembles the one in fig. 1, but which has four objectives that screw into one another, and can therefore be combined in any desired manner. This is probably the microscope no. 26a in the catalogue of 1831, sold at 1,110 S.M., for the other two microscopes are omitted from this catalogue; and this microscope is said to have a magnification varying from 19 to 380, a figure which could hardly have been obtained with a single achromatic lens. In the Zeis Museum at Jena there is a microscope fitted with the right-angle prism. This is catalogued at a price of 730 S.M., in the same year's catalogue, and is said to have magnifications varying from 12 to 1,000. This microscope has the Cuff fine-adjustment screw acting upon the stage, and for coarse adjustment the body is moved by hand and then clamped to the pillar, which is rectangular.

All these microscopes are fitted with oculars which screw into the body tubes, a method largely adopted on the Continent at that date.

42. XX.—EXPERIMENTAL STUDIES IN DIFFRACTION. IV.

By Fredk. W. Shurlock.

Three Plates.

Diffraction from Geometrical Patterns.

In these experiments the diffraction patterns were reduced from drawings by photography, both dark line patterns on a clear glass ground and white line patterns on a dark ground being employed.

In each experiment the diffracting pattern was placed at a distance of 60 cms. from a pinhole of diameter 0·37 mm., which was illuminated by a continuous current arc, whilst the diffraction figures were received on a photographic plate at the distances noted below.

A. Hexagon Pattern. (Black lines.)

(1) The pattern.
(2) Diffraction figure at 25 cms.
(3) Diffraction figure at 48 cms.
(4) Diffraction figure at 80 cms.
(5) Diffraction figure at 80 cms. This was developed to show the triangular black spots.
(6) Diffraction figure at 185 cms.

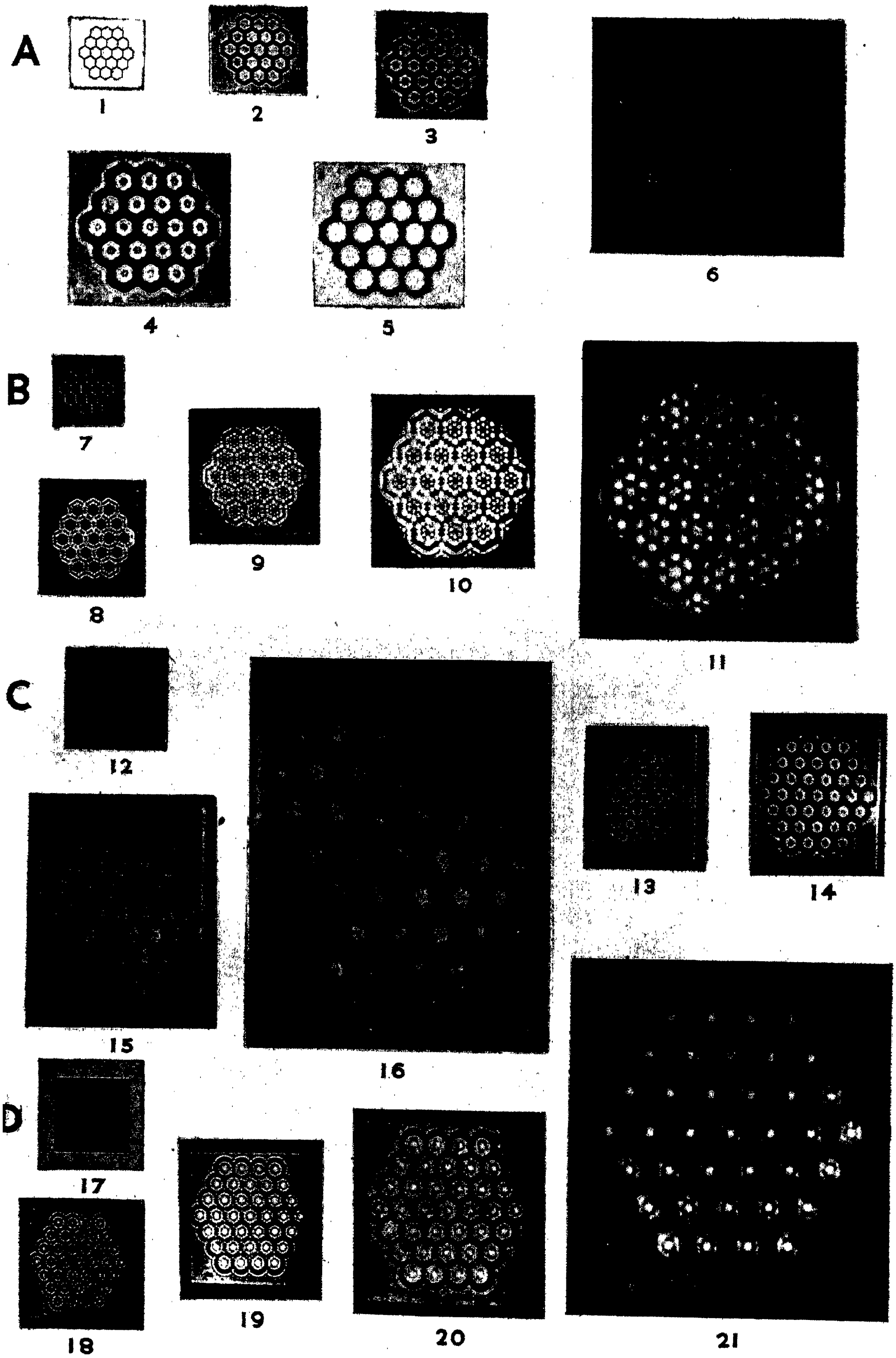
The figures consist of hexagons with detail in the sides and interiors. There are also black spots at the corners of the hexagons which appear to be due to the overlapping of the diffraction figures of three concurrent sides. They are reminiscent of the spots which may be seen at the corners of the hexagons in microphotographs of *Triceratium favus*.

In fig. 5, at 80 cms., the black spots become triangles with convex sides. As the distance increases, the interior figures join up with radial lines to the sides of the hexagons to form a six-rayed star pattern.

B. Hexagon Pattern. (White lines.)

(7) The pattern.
(8) Diffraction figure at 25 cms.

The sides of the inner hexagons are white, and are crossed by three diamond-shaped dark patches symmetrically placed. The interior figures are hexagonal. There is first a dark border: inside this is a hexagon, each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side of which consists of three white spots, the corner spots being the brighter. This in turn encloses a hexagon, each side of which consists of two white spots. This hexagon encloses a central white spot.

(9) Diffraction figure at 48 cms.

The sides of the hexagons are crossed by two diamond-shaped dark patches. These are connected by two faint arms to the interior figure, forming a double six-rayed star pattern. The dark border of the interior figure has concave sides. Inside this is a hexagon, each side of which consists of two white spots. Inside this, again, is a dark ring with a central spot.

(10) Diffraction figure at 80 cms.

The figure is generally similar to that at 48 cms. The boundaries of the hexagons are darker, as are the diamond patches that cross them. Three white spots show clearly in each side, those at the corners being accentuated. The concave sides of the dark border of the interior figure are fainter, and the six white spots which it encloses are more pronounced. The central spot is white.

(11) Diffraction figure at 185 cms.

At this distance the sides of the hexagon are dark, and are crossed by simple diamond-shaped patches which give rise to a well-marked six-rayed star pattern.

C. Circle Pattern. (Black lines.)

(12) The pattern.
(13) Diffraction figure at 25 cms.

There is detail in the overlapping projections of the dark circles and faint circular diffraction figures in the interior.

(14) Diffraction figure at 48 cms.

The interior figures are relatively smaller and have a central black spot. Six double transverse bands in the projections of the dark circles form with each interior figure a six-rayed star.

(15) Diffraction figure at 80 cms.

The six-rayed stars are relatively more prominent and form a triangular pattern over the field. There are no central black spots.

(16) Diffraction figure at 185 cms.

There are black spots in the overlapping projections of the dark circles, and there are faint dark central spots in the interiors. There is a general resemblance to the figure obtained from the black-lined hexagon pattern.

D. Circle Pattern. (White lines.)

The figures obtained from the white-lined circle pattern are somewhat like those of the white-lined hexagon pattern: the interior figures are, however, circles instead of hexagons.

(17) The pattern.
(18) Diffraction figure at 25 cms.

In the projection of each circle there are six groups of four transverse diamond-shaped dark patches, giving rise to a hexagon pattern over the field. The interior figure is the ordinary one for a circular aperture; in this case, three dark rings with a white centre.

(19) Diffraction figure at 48 cms.

The diamond patches occur in groups of three. The interior figure has two dark rings and a white centre.

(20) Diffraction figure at 80 cms.

The diamond patches occur in groups of two. The interior figure has two dark rings and a faint dark central spot.

(21) Diffraction figure at 185 cms.

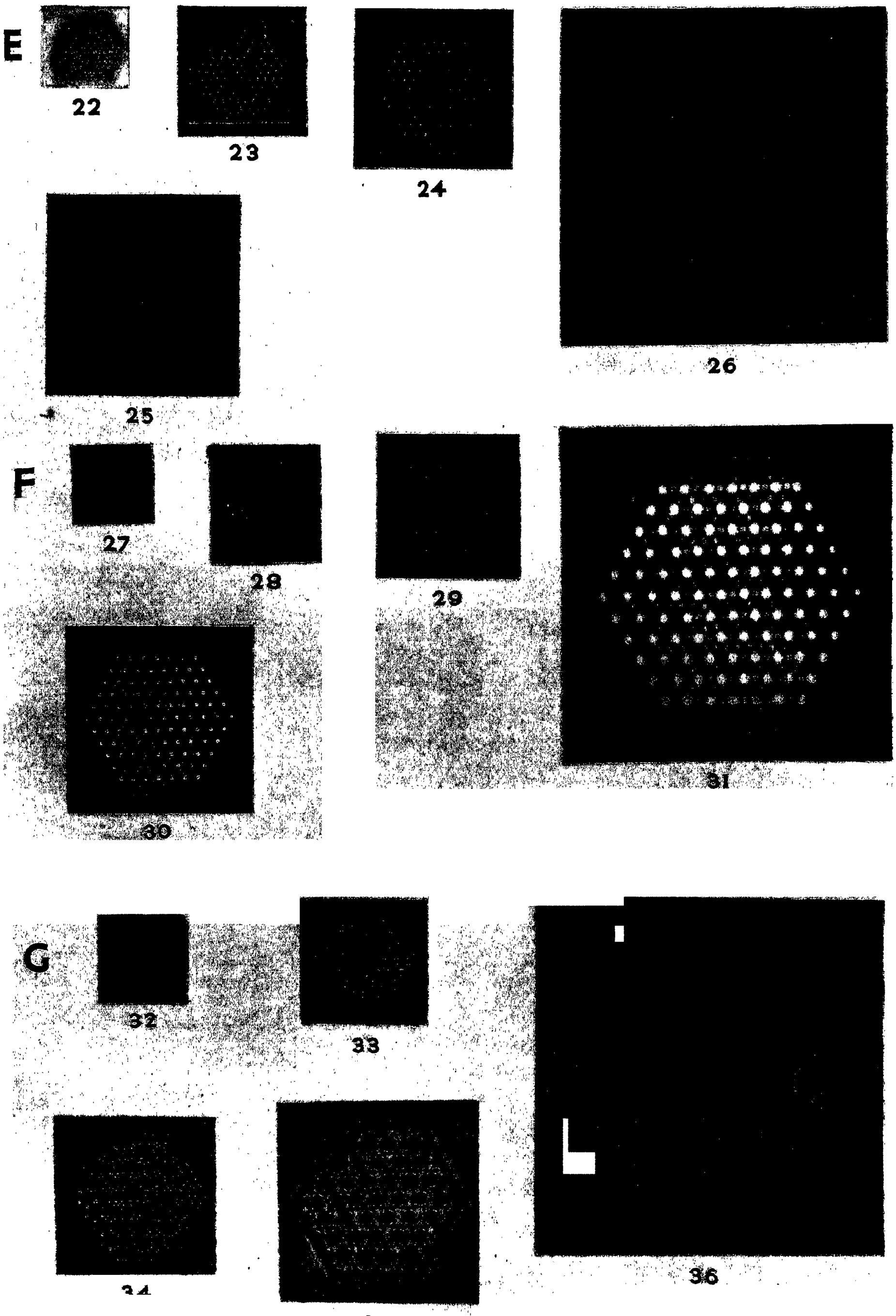
The interior figure is a dark ring having a bright centre and with traces of a central dark spot. The bright centres are joined by dark lines, which form a well-marked triangular pattern. The projections of the original white circles are dark, whilst the bright centres joined by dark lines give rise to a well-marked triangular pattern very different from the circle pattern of the original object.

E. Second Hexagon Pattern. (Black lines.)

(22) The pattern.

The hexagon pattern previously employed is a repetition pattern in which the hexagons fill the available space. In this second pattern subsidiary equilateral triangles fill the spaces between the hexagons.

The pattern is formed by three sets of parallel lines which intersect in pairs at angles of 60°. Two sets of these form a rhombus pattern, which fills completely the available space. The third set bisects the sides of these rhombuses, giving a hexagon pattern with equilateral triangles. The hexagons are arranged in rows in the directions of the three sets of parallel lines, contiguous hexagons touching in one point only. The spaces are occupied by equilateral triangles, also in rows, in the directions of the three sets of parallel lines. Each side of a hexagon has an equilateral triangle external to it, and the sides of any triangle are also sides of three hexagons.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This pattern is quoted in a discussion of the Abbe experiments (fig. 63, p. 69, " The Microscope and its Revelations," Carpenter-Dallinger, 7th ed., 1891) as the theoretical image of an object, such as *Pleurosigma angulatum*, which gives six diffraction images of the source in the back focal plane of the objective, arranged symmetrically round the circumference of a circle.

(23) Diffraction figure at 25 cms.

The appearance is that of a hexagon pattern in which the hexagons completely fill the available space; the hexagons are dark on a bright ground, and have black triangular spots at the angular points, with considerable detail in the sides. Each black triangle has three oval curves adjacent to it, the long axes of the curves being parallel to the sides of the triangle. There are dark spots at the ends of the minor axes of the curves.

(24) Diffraction figure at 48 cms.

The pattern is now divided into equilateral triangles with bright sides and dark centres. Corresponding to a row of hexagons in the original design we now have a row of rhombuses, each rhombus being divided by a diagonal into equilateral triangles. Each side of a triangle consists of four white spots, the spots at the vertices being the largest and brightest. The insides of the triangles are dark with black patches, roughly triangular, at the vertices.

(25) Diffraction figure at 80 cms.

The same pattern persists, but is rather less distinct, and the spots at the vertices of the triangles are larger.

(26) Diffraction figure at 185 cms.

The field is completely occupied by hexagons; the sides of the hexagons are dark, with still darker patches at the angular points.

F. Second Hexagon Pattern. (White lines.)

(27) The pattern.
(28) Diffraction figure at 25 cms.

The field is covered by a hexagon pattern. The centre of each hexagon is bright and is surrounded by a faint dark ring; outside the ring is a bright hexagonal star; between consecutive rays of the star there is a dark oval figure crossed by dark lines.

(29) Diffraction figure at 48 cms.

The bright centres of the hexagons are larger. The pattern shows signs of breaking up into bright double-rayed stars with dark rectangular figures in each ray.

(30) Diffraction figure at 80 cms.

Bright hexagons still cover the field. There are two dark spots in each side, and there are fainter interior dark hexagons with bright centres.

(31) Diffraction figure at 185 cms.

The hexagons have broken up into equilateral triangles with bright sides, each consisting of three white spots, the spots at the vertices being larger than those in the middle of the sides. The interiors of the triangles are dark, with darker spots at the vertices.

G. Equilateral Triangle Pattern. (Black lines.)

(32) The pattern.
(33) Diffraction figure at 25 cms.

The projection lines are broadened; there is a dark hexagonal star at each vertex of the triangles, and a fainter oval figure in the middle of each side. The borders of the oval figures are bright, and the ovals adjacent to a dark star are themselves arranged in the form of a hexagon.

(34) Diffraction figure at 48 cms.

The dark hexagonal stars are now relatively larger, and the hexagon pattern shows more detail. There are conspicuous white spots at the points of each star. The oval figures are reduced to short black lines, whilst the bright borders of these lines form a circle with inscribed hexagon round each star.

(35) Diffraction figure at 80 cms.

This figure bears a general resemblance to that at 48 cms., but the white spots are triangular in shape.

(36) Diffraction figure at 185 cms.

At this distance the detail in the hexagon patterns is lost, so that we have a plain white hexagon enclosing each star. The star now consists of a dark hexagon with rays at each angular point and a dark central spot.

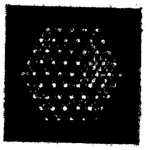
H. Equilateral Triangle Pattern. (White lines.)

(37) The pattern.
(38) Diffraction figure at 25 cms.

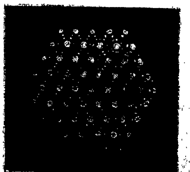
In this figure there are circular white spots with dark borders at the vertices of the triangles in place of the dark hexagonal stars in the black line figure. Each of these spots is surrounded by twelve white spots, the

H

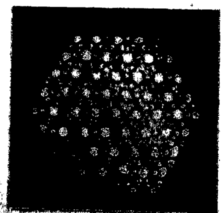
37



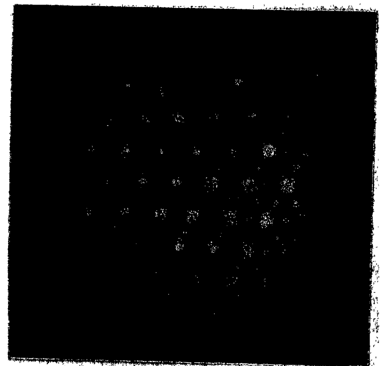
38



39

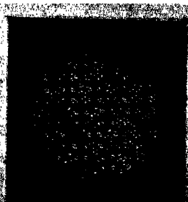


40



41

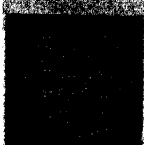
I



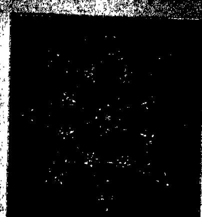
42

43

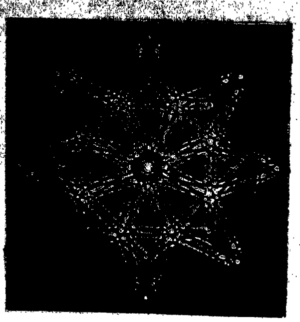
J



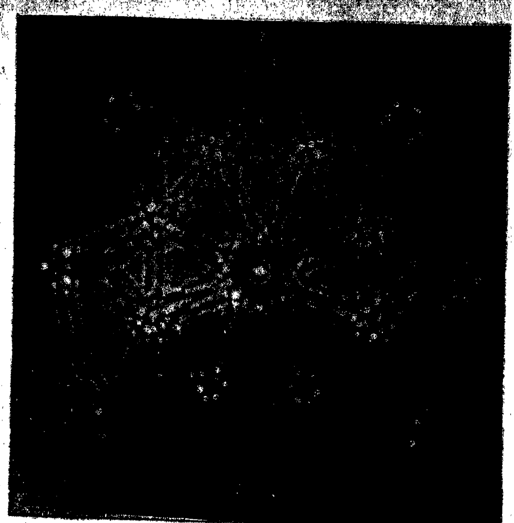
44



45



46



47

alternate spots forming two sets of different intensity. Pairs of fainter dark lines from each of the larger spots bisect the angles of the triangles. There is a slight external grating effect.

(39) Diffraction figure at 48 cms.

The larger spots become distinctly hexagonal. The smaller white spots form double rows separated by dark lines. The external grating effect is enhanced.

(40) Diffraction figure at 80 cms.

The double lines become single, giving faint white spots arranged in hexagonal form round the larger white discs. The grating effect is again enhanced.

(41) Diffraction figure at 185 cms.

The figure resembles that obtained at 80 cms. but the smaller spots are bolder. The grating effect is now very pronounced.

I. Diffraction Figures from Double Pinhole.

(42) Diffraction figure from the hexagon pattern B (white lines) at 80 cms.

(43) Diffraction figure from the hexagon pattern B (white lines) at 120 cms.

Figs. 42 and 43 were taken with a double pinhole. They illustrate the fact that the light from each pinhole tends to produce its own diffraction figure, and that the combination of two or more diffraction figures may give rise to a new figure.

J. Octagonal Star Pattern.

(44) The pattern.

(45) Diffraction figure at 20 cms.

(46) Diffraction figure at 50 cms.

(47) Diffraction figure at 120 cms.

These interesting figures exhibit standard features and, as usual, become more complex as the distance increases.

ABSTRACTS AND REVIEWS.

ZOOLOGY.

(*Under the direction of* G. M. FINDLAY, M.D.)

HISTOLOGICAL TECHNIQUE AND STAINING.

Isohematein as a Biological Stain.—E. C. COLE (*Stain Technol.*, 1931, **6**, 93–6). Isohematein has greater tinctorial power than hæmatoxylin (hematein), but is not nearly so selective for nuclei. In sections of cat spinal cord, however, the cell bodies of the neurones were well differentiated. Fibrillæ in smooth muscle cells and cross striations in skeletal muscle were also well brought. Isohematein is in the form of small jet black glossy crystals: it is soluble in ethyl alcohol of 70 p.c. or higher grades. In solutions below 70 p.c. there is precipitation. A mordant is required for successful staining. G. M. F.

A Modification of Mallory's Triple Stain.—B. KRICHESKY (*Stain Technol.*, 1931, **6**, 97–8). Results with Mallory's triple connective tissue stain are apt to be uncertain. With this modification differentiation is said to be sharp, clear and, above all, consistent. Tissues fixed in Bouin's or Zenker's fluid are suitable. The staining solutions are:—Solution 1: Acid fuchsin (dye content 62 p.c.) 0·25 g.; water 100 c.cm. Solution 2: A. Aniline blue 2·0 g.; water 100 c.cm. B. Orange G (dye content 83 p.c.) 1·0 g.; water 100 c.cm. C. Phosphomolybdic acid 1 p.c. 100 c.cm. Solutions A, B and C should be kept in separate bottles, as the mixture deteriorates on standing. When ready for use, solution 2 is made up of equal parts A, B and C. Sections taken down to water and washed for 5 minutes are transferred to solution 1 for from 1 to 3 minutes, the time to be estimated by experience; washed by dipping the slide into water till the surface stain is removed; transferred to solution 2 for from 3 to 5 or more minutes; washed by dipping the slide into water from 1 to 3 times only; dipped 3 times in 70 p.c. alcohol and 5 to 8 times in 80 p.c. and 95 p.c. alcohol; dehydrated in absolute alcohol for several minutes; cleared in xylol and mounted in damar. G. M. F.

A Simple Method of Staining Spirochætes.—A. BESSEMANS and L. VAN DEN BERGHE ("Procédés simples et rapides de coloration pour tréponèmes et leptospires," *Compt. rend. Soc. de la Biol.*, 1931, **107**, 1571–3). The various methods of staining spirochætes have been critically compared in regard to the length of time taken over the process, the intensity of the colouration, and the deformation of the spirochætes. The technique described by Mühlpfordt (*Dermat*

Wchnschr., 1924, **79**, 921) is the most satisfactory if the smears are first fixed for 2 to 4 minutes either in formol acetic acid or in a 10 p.c. solution of formalin in alcohol. The smears are then stained for 2 or 3 minutes in a 3 p.c. aqueous solution of Victoria blue 4R (Grübler), washed and dried. G. M. F.

Aqueous Solutions of Cresyl Blue.—W. C. HOLMES and A. R. PETERSON (" The Atmospheric Dealkylation of Aqueous Solutions of Cresyl Blue," *Stain Technol.*, 1931, **6**, 79–82). Aqueous solutions of cresyl blue are much less stable than those of methylene blue. An appreciable degree of dealkylation occurs even under only very slightly alkaline conditions (e.g., at *p*H 7·68) and at room temperatures within a period of a few weeks. At *p*H 9 the dye is distinctly affected within 24 hours. G. M. F.

Two New Methods for the Rapid Diagnosis of Tissues.—A. M. HJORT and C. H. MOULTON (" New Rapid Methods for Tissue Diagnosis," *Stain Technol.*, 1931, **6**, 83–91). The method of Geschickter, Walker, Hjort and Moulton (this Journal, 1931, **51**, 139) is modified to produce more permanent preparations. Sections 5 to 10μ in thickness are placed in a phosphate buffer solution at *p*H 7·0 for at least 15 seconds, then transferred to a dehydrating bath consisting of diethylene lgycol 30 parts and 95 p.c. grain alcohol 70 parts for 5 seconds. The sections are then placed in the compound stain for from 10 to 15 seconds. This stain may consist of one of the following :—(1) Thionin eosinate 1 p.c. ; (2) thionin eosinate 1 p.c. and the barium or calcium salts of eosin or erythrosin 0·5 p.c. ; (3) thionin eosinate 0·8 to 1·0 p.c. and eosin 0·2 p.c. The solvent used is diethylene glycol 40 parts, ethylene glycol 40 parts, and 95 p.c. grain alcohol 20 parts. Float for 5 to 10 seconds in the first of two washing baths of the same composition as the dehydrating bath, then transfer to a second washing bath for 30 to 60 seconds, until the desired colour is obtained. Pass the section into ethylene glycol monobutyl ether for 5 seconds. Float onto a bath of ethyl phthalate for 5 to 10 seconds. Float the section on a glass slide, blot with lintless blotting-paper and mount with neutral xylol-gum-damar. Three to 5 minutes are required for the whole process. Fresh preparations may also be stained by hæmatoxylin and eosin. Delafield's or Harris' hæmatoxylin is the most suitable. After cutting the sections they are transferred to formalin of from 4 to 40 p.c. strength, where they remain for at least 15 seconds. (i) Transfer with glass rods to the hæmatoxylin. for 30 to 60 seconds. (ii) Float in water for 5 seconds. (iii) Decolourize in 0·1 p.c. hydrochloric acid for 5 seconds. (iv) Wash in water 5 seconds. (v) Float onto 0·5 p.c. ammonia for 5 to 10 seconds. (vi) Wash in water for 5 seconds. (vii) Transfer to diethylene glycol 30 parts and 95 p.c. grain alcohol 70 parts for 5 seconds. (viii) Float onto eosin for 1 minute. This stain is a 1 p.c. solution of eosin in diethylene glycol 40 parts, ethylene glycol 40 parts, and 95 p.c. grain alcohol 20 parts. (ix) Pass for 5 to 10 seconds into a dehydrating bath of the same composition as (vii), but saturated with calcium hydroxide. (x) Float onto another dehydrating bath of the same composition for 5 seconds. (xi) Transfer to ethylene glycol monobutyl ether for 5 seconds. (xii) Float onto ethyl phthalate for 5 seconds, then onto a slide, blot and mount in neutral gum damar or balsam. G. M. F.

The Diagnosis of Diphtheria.—S. A. SCUDDER (" A Differential Stain Favorable to the Diagnosis of Neisserian Infection," *Stain Technol.*, 1931, **6**, 99–106). Pyronin has an affinity for the diphtheria bacillus and acts as an inert substance upon most other proteins (except the cytoplasm of eosinophils, lymphocytes, plasma cells and endothelial cells). The following technique is recommended.

Air-dried films are stained for from 3 to 5 minutes in a 1 p.c. solution of crystal violet in 10 parts of Clark and Lubs phosphate buffer of pH 6·6 to 7·0 and 90 parts water. Decant and flush with 2 p.c. iodine in N/10 NaOH. Decant and decolourize in acetone for 10 seconds or less. Air dry and counterstain 1·5 to 2 minutes with methyl-green pyronin (2 parts 2 p.c. aqueous methyl green with 1 part 0·3 p.c. aqueous pyronin yellowish). Wash and air dry. Oil of Bergamot is best as a clearing agent. Best results are obtained if each slide is handled separately as for staining blood films. G. M. F.

Bacillus subtilis and Ultra-Violet Photomicroscopy.—R. W. G. WYCKOFF and A. L. TER LOUW ("Some Ultra-Violet Photomicrographs of *B. subtilis*," *J. Exp. Med.*, 1931, **54**, 449–51). Ultra-violet photomicrographs of *B. subtilis* are reproduced, and the causes of spore formation are discussed in relation to the appearances. G. M. F.

Cytology.

The Factors Limiting the Growth of Tissues in vitro.—B. EPHRUSSI ("Sur les facteurs limitant l'accroissement des cultures des tissus *in vitro*. Signification de l'énergie résiduelle," *Compt. rend. de l'Acad. des Sc.*, 1931, **192**, 1763–5). When fibroblast cultures of different size were grown in heparinized plasma, the final size of the cultures was proportional to the initial size, but the rate of proliferation of the smaller fragments was greater than that of the larger. The arrest of growth of the cultures is due to the absence of proteins containing the – SH radical. G. M. F.

The Histology of the Connective Tissue Stroma of the Human Placenta. The Connective Tissue of the Decidua.—I. COSTERO ("Observaciones histológicas sobre el estroma conjuntivo de la placenta humana," *Bol. de la Real Soc. españ de Hist. Nat.*, 1930, **31**, 167–86, 13 text-figs.). An exhaustive account is given of the connective tissue elements in the decidua of the human placenta. G. M. F.

The Chemical Nature of the Golgi Apparatus.—D. H. TENNENT, M. S. GARDINER, and D. E. SMITH ("A Cytological and Biochemical Study of the Ovaries of the Sea-Urchin, *Echinometra lucunter*," *Papers from Tortugas Laboratory of the Carnegie Institute of Washington*, 1931, **27**, 1–46, 7 pls.; also *Publication No.* 413, *Carnegie Institute*, 1–46). The observations recorded in this communication represent an attempt to define more closely the chemical constitution of the substances which, after Mann-Kopsch and Champy-Kull fixation, represent the Golgi apparatus and mitochondria of the cytologist. Ova of the sea-urchin, *Echinometra lucunter*, could be obtained in large quantities. Cytological preparations were made by the Ludford first modification of the Mann-Kopsch method and by Champy-Kull fixation. An alcoholic extract of the tissues was also prepared, and the ether-soluble portion fractionated into total fats, cerebrosides, cephalin, lecithin, cholesterol and fats, cholesterol, mixed fatty acids, saturated fatty acids, unsaturated fatty acids, neutral fat and pigment. Each of these fractions was subjected to Mann-Kopsch and Champy-Kull fixation, both alone and in various combinations. The paper should be read in its entirety by those interested in the Golgi apparatus. The results of the study of the extracted substances show that it is only when fatty acids of the oleic series or of a more highly unsaturated series are present that persistent blackening can be secured. While the ability to blacken after prolonged osmication and treatment with turpentine satisfies the specification for a Golgi apparatus, it is obvious that unsaturated fatty

acids cannot be a general explanation of Golgi substance. Lactic acid and reducing sugars in an alkaline medium also produce persistent blackening with osmic acid, and satisfy the conditions in muscle and in plant cells. A considerable number of entirely distinct chemical substances are thus capable of reducing osmium tetroxide to a black colloidal solution from which, in the course of hours or days, there will be a precipitation of the dispersed particles. Cephalin stains with Janus green B in a dilution of 1 in 40,000. If the results of osmic impregnation are used as a criterion, there is no specific Golgi substance characteristic of all cells as chromatin is characteristic of all nuclei. G. M. F.

Bartonella in Rodents.—R. Bruynoghe and J. Jadin ("Les Bartonella des rongeurs," *Compt. rend. Soc. de la Biol.*, 1931, **107**, 1601–2). Bartonella found in the field mouse, *Mus sylvaticus*, are of a different species to those of the rat. G. M. F.

The Golgi Apparatus in the Active Thyroid.—L. Wagschal ("L'apparcil réticulare de Golgi et sa position dans le cas de l'hyperactivité thyroïdienne expérimentalement provoquée," *Compt. rend. Soc. de la Biol.*, 1931, **107**, 1015–17, 1 text-fig.). In the cells of the thyroid of the guinea-pig stimulated by the injection of pituitary extract the Golgi apparatus is seen near the free margin of the cell and never in the basal portion of the cytoplasm. G. M. F.

Rickettsia in the Endothelial Cells of the Membrane of Descemet in Animals Inoculated in the Anterior Chamber of the Eye with the Virus of Typhus from San Paolo.—J. Lemos Monteiro ("Présence de Rickettsias dans les cellules endothéliales de la membrane de Descemet chez des animaux inoculés dans la chambre antérieure de l'œil avec le virus du typhus exanthématique de Sao Paulo," *Compt. rend. Soc. de la Biol.*, 1931, **107**, 1161–4, 2 text-figs.). The Rickettsia are present in large numbers from the second to fifth day in the guinea-pig and rhesus monkey. G. M. F.

Rickettsia in Tissue Cultures.—H. Pinkerton and G. M. Hass ("Typhus Fever. III. The Behavior of *Rickettsia prowazeki* in Tissue Culture," *J. Exp. Med.*, 1931, **54**, 307–13, 1 pl.). Typhus Rickettsiæ are found in large numbers in sections of tissue cultures of scrotal sac exudate. Extensive multiplication of the organisms occurs and new cells become infected. Organisms are seen in cells undergoing mitotic division. The organisms usually become less numerous after the sixth day *in vitro*, but in one instance organisms were extremely numerous on the sixteenth and twenty-first days. Their intracellular location is retained even when infection is very heavy. Multiplication occurs exclusively in non-phagocytic cells which are believed to be of mesothelial origin. Pleomorphism is much more pronounced in tissue cultures than in guinea-pig tissues, and is entirely comparable to that seen in the louse. G. M. F.

The Formation of Plasma Cells.—F. R. Miller ("The Induced Development and Histogenesis of Plasma Cells," *J. Exp. Med.*, 1931, **54**, 333–48, 2 pls.). By injecting tuberculo-protein into the omenta of rabbits it was found possible to produce large numbers of plasma cells in the subserosal connective tissues of the omentum, body wall, and intestinal wall. The precursor of the plasma cell is a primitive connective tissue cell in which there is an increase in the basophilia of the cytoplasm, the nucleus becomes eccentric, a condensation of the chromatin occurs near the nuclear membrane, and there is a loss of nucleoli. At the time when the nucleus assumes the eccentric position, the clear area appears in the centre of the cytoplasm. The early cells are capable of reproducing themselves by mitosis,

while the typical mature cells divide by amitosis. The mature plasma cells often have muddy, spongy cytoplasm which contains acidophilic or hyaline granules as the cells begin to degenerate. Cells with granules or hyaline bodies generally have pycnotic or fragmented nuclei. These cells are the final stage reached by some plasma cells. Others, when degenerating, show vacuoles and signs of senility. Those with the granules and hyaline bodies are the so-called Russell body cells. The plasma cells are met with in the blood stream as well as in the tissues. When studied supravitally, they are characterized by their deep yellowish-gray cytoplasm, indistinct eccentrically placed nuclei, and numerous mitochondria. G. M. F.

The Action on Normal and Neoplastic Tissues Grown in vitro of Alkaline and Magnesium Vanadium Chromates. — A. H. Roffo and O. Calcagno ("Estudio biológico de los vanadocromatos alcalinos y de magnesia, sobre el desarrollo de los tejidos normales y neoplásicos *in vitro*," *Rev. Méd. latino-americana*, 1931, **16**, 1297–1320). Vanadium chromates have a strong inhibitory action on the growth of normal and malignant tissues in tissue cultures. This inhibitory action is greater than that exhibited by the corresponding vanadates, and is due to the presence of the chromium atom in the molecule. G. M. F.

Supranormal Temperatures and Tissue Cultures.—G. Pincus and A. Fischer ("The Growth and Death of Tissue Cultures exposed to Supranormal Temperatures," *J. Exp. Med.*, 1931, **54**, 323–32, 1 pl.). When chicken osteoblasts in cultures are exposed for prolonged periods at 42° C. and 44° C., there is no lethal effect. Cultures are killed after an exposure of 105 minutes at 47° C., of 6 minutes at 50° C., and of 3·5 minutes at 52° C. A definite inhibition of growth occurs after different exposures at all temperatures from 44° C. onwards. There is a latent period of about 24 hours before any discernible effects of sublethal or just lethal exposures; this latent period appears to be independent of the duration of the sublethal exposure and of the temperature. The high temperature coefficients for lethal exposures and for exposures just sufficient to inhibit growth indicate an underlying "destructive" process in the cells of the culture.
G. M. F.

The Reaction of Living Tissues to X-Rays.—W. Moppett ("The Reaction of Living Tissues to Homogeneous X-Radiation Produced by Crystal Diffraction," *Proc. Roy. Soc. B.*, 1931, **108**, 503–10, 1 pl.). An adaptation of the X-ray spectrometer used for experiments on the allantoic membrane of chicks was employed for experiments on the skin of the mouse. Homogeneous radiation of certain wave-lengths was found to produce hypertrophy of the skin. G. M. F.

Histology.

Territories of Regeneration and Transplantations.—E. Guyénot and K. Ponse ("Territoires de régénération et transplantations," *Bull. Biol. de la France et de la Belgique*, 1930, **64**, 251–87, 2 pls., 7 text-figs.). In batrachians (Triton) and in saurians (lizard) the organization of the adult is a mosaic of territories of regeneration having different morphogenic potentialities. This, however, is not a general law, and does not hold for hydra, planarians, or the earthworm. The conception of territories of regeneration is suceptible of experimental proof by (1) The technique of deviation of nerve trunks, by means of which growth can be excited in various areas which respond specifically; (2) the complete extirpation of territories, thereby suppressing the regeneration of corresponding parts; (3) the transplantation of territories which preserve their characteristic

morphological capacities wherever they are grafted. To interpret the experimental results correctly it is essential to differentiate between the regeneration of the foot and the tail. The first is a case typical of auto-differentiation of a predetermined bud, at the expense of which all the regenerated parts are newly formed. The second represents the superposition of an autonomous process for the realization of the general form by proliferation of certain tissues of the stump. Nerves do not exercise any specific morphogenic action. The connective tissue represents the material from which buds of regeneration are formed. G. M. F.

Local Effects on the Rat of High-Frequency Currents.—J. SAIDMAN, J. MEYER, and R. CAHEN ("Effets locaux dus aux champs électriques de très haute fréquence chez le rat," *Compt. rend. de l'Acad. des Sc.*, 1931, **192**, 1760–2). Regional irradiation has relatively little effect on the general body temperature, but the temperature of the part irradiated is raised. When the abdomen of the rat is irradiated, death occurs if the local temperature reaches 43·5°, and is not fatal when 41·5° is not exceeded. Histologically there is intense congestion with vascular thrombosis. G. M. F.

The Calcifying Action of Bismuth.—C. LEVADITI, A. VAISMAN, R. SCHOEN and Y. MANIN ("Action calcificante du bismuth," *Compt. rend. de l'Acad. des Sc.*, 1931, **192**, 1768–9). Bismuth salts injected in toxic doses into rabbits cause the accumulation of calcium salts at the site of injection in the muscles and in the kidneys at the end of five days. G. M. F.

Mollusca.

Sex Change in the European Oyster.—J. H. ORTON and C. AMIRTHALINGAM ("Observations and Experiments on Sex-Change in the European Oyster (*O. edulis*). Part II. On the Gonad of Egg-Spawning Individuals," *Journ. Marine Biol. Assn.*, 1931, **17**, 315–24, 12 text-figs.). In this paper figures are given to illustrate successive stages of the gonad after egg-spawning, and also the state of the ripe female gonad in the spawning condition. As the condition of the gonad can usually be easily and quickly ascertained by an examination of a fresh preparation of the gonad, fresh preparations are also figured. To obtain fresh preparations of the gonad of the oyster, a cut may be made in the visceral mass near the pericardium or dorsally near the loop of the intestine which encircles the stomach. When the cut is made, a microscope slide is pressed gently against the cut to collect a little of the exuded fluid. This fluid is examined microscopically without a cover-slip and without adding sea-water. To test the ripeness of the sperm, sea-water may afterwards be added, when the ripe sperm-morulæ break up into active sperm on the slide. G. M. F.

The Gills in Mytilus edulis.—D. ATKINS ("On Abnormal Conditions of the Gills in *Mytilus edulis*. Part II. Structural Abnormalities, with a Note on the Method of Division of the Mantle Cavity in Normal Individuals," *Journ. Marine Biol. Assn.*, 1931, **17**, 489–543, 27 text-figs.). The chief abnormalities were folding over of the free ventral edge of the gill, with concrescence, fusion of the gill filaments side by side, enlargement of the gill filaments and concrescence of the two gills of one side. G. M. F.

The Labial Palps and Foot of Mytilus edulis.—D. ATKINS ("Note on Some Abnormalities of Labial Palps and Foot of *Mytilus edulis*," *Journ. Marine Biol. Assn.*, 1931, **17**, 545–50, 7 text-figs.). A record of certain abnormalities in the types of palps and of the foot. G. M. F.

Regeneration of the Gill of Mytilus edulis.—D. Atkins ("Note on the Regeneration of the Gill of *Mytilus edulis*," *Journ. Marine Biol. Assn.*, 1931, **17**, 551–66, 8 text-figs.). Experiments are described to show that the gill of *Mytilus* is capable of regeneration, which may occur in less than eight months; but regeneration does not occur regularly, though the reasons for this are obscure.

G. M. F.

The Natural History of Bulla hydatis Linn.—N. J. Berrill (*Journ. Marine Biol. Assn.*, 1931, **17**, 567–71, 1 text-fig.). The larvæ on hatching are able either to swim as veligers or crawl as gastropods. The postponement of hatching till the veliger phase is almost over is considered to be a direct result of yolk accumulation within the egg. G. M. F.

Arthropoda.

Insecta.

The Genus Iolana.—A. F. Hemming ("Revision of the Genus *Iolana* Beth.-Baker (Lepidoptera, Lycænidæ)," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 323–33, 1 pl.). The title is indicative of the subject-matter of this paper. A new genus and several new subspecies are defined. M. E. M.

New Species of Forcipomyia.—B. de Meillon ("A New Species of *Forcipomyia* (Diptera, Ceratopogonidæ) from the Transvaal, with a Description of its Early Stages," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 335–40, 17 text-figs.). The larvæ of this midge were found beneath the bark of a dead pine stump. They were seen to be feeding on the rotting bark and cambium, and, associated with the pupæ, were present in fairly large numbers. An account of the morphological characters of the male and female larvæ and pupæ is provided. M. E. M.

New African Lymantriidæ.—C. L. Collenette ("New African Lymantriidæ in the British Museum Collection," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 341–63, 1 pl.). In all, one new genus and 39 species are defined. M. E. M.

Wing Development in Lepidoptera.—F. A. Dixey ("Development of Wings in Lepidoptera," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 365–93, 19 text-figs.). The author's summary is too long to give *in extenso*, but the following are extracts from it. The wing of Lepidopterous insects originates in an invagination of the larval hypoderm. The wing rudiments result from a secondary infolding of the upper layer of the original invagination. The envelope is formed by a folding of the lower layer of the original invagination round the wing rudiment. The veins of the adult wing are foreshadowed by sheaths of basement membrane. The hypoderm cells investing these sheaths undergo modification. Just before emergence the two surfaces of the wing are seen to be bound together by numerous bundles of fibres derived from the upper and under basement membranes, which do not follow the undulations of the hypoderm. These bundles, on the expansion of the wing after exclusion, become resolved into their constituent fibres, which pass across the cavity of the wing at approximately equal distances. Whether they undergo contraction seems doubtful. In the fully adult fly the two wing surfaces are in complete union, the intervening cavity with its contents, except for the veins and a small area adjacent to the veins, having become entirely obliterated. M. E. M.

Coccidæ of Southern Rhodesia.—W. J. HALL ("Observations on the Coccidæ of Southern Rhodesia," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 285–303, 8 text-figs.). The paper consists of a descriptive account of the Rhodesian species of *Coccidæ*, and includes descriptions of several new species. M. E. M.

Abnormalities in Lepidopterous Larvæ.—E. A. COCKAYNE ("Three Rare Abnormalities in Lepidopterous Larvæ: Homœosis, Somatic, Spiral Segmentation," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 305–9, 1 pl.). During 1930 the author received from Mr. L. W. Newman a larva of *Brachionycha nubeculosa* Esp. which was found to have a pair of small prolegs on the seventh abdominal somite. A detailed description is given of the morphology of this abnormal member. Somatic mutation was discovered in a larva of *Cucullia umbratica* L. received from Mr. A. J. Wightman. This had the head of the usual dark brown colour with faint orange stripes, but the rest of the larva was sharply divided down the middle line into a left half of the usual colour and the right half almost completely blackish brown. Full details are given by the author as to other associated variations in this larva. Spiral segmentation was found in a larva of *Hipocrita jacobaeæ* L. received from Mr. C. N. Hawkins. The dorsal spiral begins on the left-hand side of the metathorax. The right half of the metathoracic somite is united dorsally to the left half of the first abdominal, and the spiral ends on the right side of the first abdominal, but the separation of the two halves of this somite is incomplete. Here, again, a full description is given of associated characters in this abnormal larva. M. E. M.

Mordellidæ from New Guinea and Fiji.—A. M. LEA ("On Some *Mordellidæ* from New Guinea and Fiji," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 311–21, 2 text-figs.). Comparatively few species of *Mordellidæ* have been recorded from New Guinea, but as Mr. C. T. McNamara obtained no less than 25 species in a few months at Mount Lamington alone, it is probable that the family is as abundantly represented there as in the Cairns district of Queensland, where many of the species have only been obtained from flowers on the tops of tall trees. The author describes a large number of new species, and states that some of the New Guinea forms appear to be but slight varieties of Queensland species, and several extend to Fiji and elsewhere in the Pacific. M. E. M.

New Indian Hymenoptera.—A. C. SEN ("Notes on Some Unknown Indian *Hymenoptera*," *Rec. Ind. Mus.*, 1931, **33**, pt. 1, 21–24, 4 text-figs.). The author had his attention drawn to the fact that certain Hymenopterous insects have been recorded by Bingham in the "Fauna of British India: *Hymenoptera*," vol. I (1887), in one sex only. Since Bingham's publication examples of the other sex have been obtained in India, and are now in the collections of the Indian Museum. The author here describes the hitherto undescribed sex of each of these insects—four in all. M. E. M.

Japanese Blepharoceridæ.—S. KITAKAMI ("The *Blepharoceridæ* of Japan," *Mem. Coll. Sci., Kyoto Imp. Univ.*, 1931, **6**, no. 2, art. 4, 19 pls., 10 text-figs.). Hitherto only four species of *Blepharoceridæ* have been described from Japan, of which neither the larvæ nor the pupæ were known. During the summer of 1925 several old insect larvæ were obtained from the stomach of a salmonoid fish, and proved to belong to this family. The author has since taken up the study of the Japanese *Blepharoceridæ*, and in the present work the results of his studies are recorded. Specimens of 5 genera, 18 species and 4 varieties are described, including their larvæ and pupæ. Some account also is given of the life-histories and distribution of the species. M. E. M.

Biology of Trichocera maculipennis.—K. R. RARANDIKAR ("The Early Stages and Bionomics of *Trichocera maculipennis* Meig. (Diptera, Tipulidæ)," *Trans. Entom. Soc. Lond.*, 1931, **79**, pt. II, 249–60, 4 pls.). The larva of *Trichocera maculipennis* was found in the Cragganmore Distillery refuse at Ballindalloch. It feeds upon the slimy dark-coloured odorous residue in the distillery filters, and thus, in habits, plays the part of a scavenger. The larvæ are found at work in the dirty waste of refuse from March onwards until the end of September. The adult fly begins to appear in early April, and can be found in large numbers in and near the filter houses until the end of September. From October until March adult flies have not been observed in the locality. A continued examination of the distillery refuse during the autumn and winter months did not indicate the presence of *T. maculipennis* at any stage in the refuse. The life-cycle of *T. maculipennis*, from the time the egg is laid to the time the adult fly emerges, requires about 40 days under laboratory conditions. The egg stage lasts from 5 to 6 days; the larva requires about 25 days to complete its growth; the pupal stage extends over a week or more. The latter part of the paper deals with the general morphology of the egg, the larva, and the adult of *T. maculipennis*. A more detailed account of the anatomy of the fully developed larva is also included. M. E. M.

Alimentary Canal of Ephemeroptera.—A. PICKLES ("On the Metamorphosis of the Alimentary Canal in Certain *Ephemeroptera*," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 263–74, 2 pls.). An extensive change in the structure of the mesenteron occurs in the types studied, during which the epithelial and muscular layers become reduced, and form in the imago an extremely thin membrane. The change commences in the last nymphal instar shortly before the emergence of the subimago, and is completed in the latter stage or immediately after the imago emerges. The attenuation of these layers is brought about by simple mechanical pressure, as has been suggested, but is accompanied by phagocytosis and a phenomenon considered to be comparable to "rejuvenation." The mesenteron is the principal region of the alimentary canal affected, but a specialized region of the stomodasum is involved, and there may be some attenuation of the ileum and colon in addition. Arguments are adduced in support of the view that the subimago is the homologue of the pupa of *Holometabola*. M. E. M.

Immature Stages of Pantophthalmus tabaninius.—C. T. GREENE ("The Immature Stages of *Pantophthalmus tabaninius*, Thunberg, with Biological Notes by F. W. Urich," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 277–82, 2 pls.). This paper contains detailed descriptions of the immature stages and notes on the habits of an unusual wood-boring Dipterous larva, *P. tabaninius*. The egg stage is said to last for 0·5 month, the larval stage 4–6 months, and the pupal stage 1–6 months. M. E. M.

New Ephemeroptera from Japan.—M. UENO ("Einige Neue Ephemeropteren und Plecopteren aus Mittel-Japan," *Annotationes Zoologicæ Japonenses*, 1931, **13**, no. 2, 91–104, 8 text-figs.). The following species are described:—*Ephemeroptera*: *Bætis thermicus* n. sp., *Bætis shinanonis* n. sp.; *Ecdyonuridæ*: *Iron nipponicus* n. sp.; *Plecoptera*: *Perlodes yarizawana* n. sp., *Peltoperia naka* n. sp.; *Nemuridæ*: *Nemura* (*Protonemura*) *hotakana* n. sp. M. E. M.

Digestion of Starch in the Silkworm.—O. SHINODA ("On the Starch Digestion in the Silkworm," *Annotationes Zoologicæ Japonenses*, 1931, **13**, no. 2, 117–25, 2 text-figs.). It is stated that a certain race of silkworm is unable to

digest starch, although protein digestion is satisfactory. The blood of such silkworms contains deramidase, and, therefore, synthesis of carbohydrates from proteins is effected in the absence of starch digestion. In silkworms of this race, and possibly others, the hind intestine is apparently impermeable to glucose.
M. E. M.

New Cetoniid Beetles from Formosa.—T. O. Kano ("Some New or Unrecorded Cetoniid Beetles from Formosa," *Annotationes Zoologicæ Japonenses*, 1931, **13**, no. 2, 127-34, 5 text-figs.). In identifying some Formosan beetles and other *Coleoptera* collected by the author during his stay in Formosa, certain new and unrecorded species belonging to the family *Cetoniidæ* were found. Descriptions of these are given in the present paper. The types of all forms described are in the author's collection. M. E. M.

Biology of Mayetiola avenæ.—A. Ricchello ("Descrizione e notize della *Mayetiola avenæ* March. (Diptera, Cecidomyidæ) in Italia," *Annali del Regio Istituto Superiore Agrario di Portici*, 1931, **4**, ser. III, 1–70, 25 text-figs.). A comparative description is given of the morphological characters of the male and female *Mayetiola avenæ* and the two sexes of *Mayetiola destructor*. The descriptions of the former species are detailed, and present a considerable amount of information, including an account of the male and female genitalia. Detailed descriptions of the first, second, and third larval stages follow, together with that of the pupal stage. The author then deals with the geographical distribution of *M. avenæ*, and gives a list of the normal food plants of the species. The extent of the economic damage which this fly inflicts is discussed, while the type of injury to the crop plants is shown by means of photographic illustrations. The author concludes his paper with an account of preventive and curative agricultural methods. M. E. M.

Biology of Ceratitis capita.—G. Constantino ("Contributo alla conoscenza della mosca frutta (*Ceratitis capita* Wied., Diptera, Trypaneidæ)," *Annali del Regio Istituto Superiore Agrario di Portici*, 1931, **4**, ser. III, 71–154, 20 text-figs.). A very complete account of the morphology and biology of the fruit-fly *Ceratitis capita* is given in this paper. Detailed descriptions of the economic losses incurred by the activities of this fly are presented, and the methods for its control are fully discussed. The paper includes 11 pages of references to the literature.
M. E. M.

Beetles of the Island of Quelpart.—J. Murdyama ("Révision des familles des Ipides et Platypides (Coléoptères) de l'Île de Quelpart," *Annotationes Zoologicæ Japonenses*, 1931, **13**, no. 2, 39–56, 2 pls.). The work is based on a collection made by the author, in 1928, in the island of Quelpart, Southern Korea, and the title is descriptive of the subject-matter. A total of 12 species is dealt with. M. E. M.

Insect Life in the Coal Forests.—F. G. North ("Insect Life in the Coal Forest, with Special Reference to South Wales," *Trans. Cardiff Naturalists' Soc.*, 1929, **62**, 16–44, 3 pls., 10 text-figs.). The scope of this paper includes the following:—Nature of the material for study; synopsis of the classification of recent and carboniferous insects; fossil insects of the South Wales coalfield; the significance of the coal measure insects; some arachnids and a millipede; the ancestry of the insects and arachnids; list of insects and arachnids recorded from the coal measures of South Wales; and a list of references to the literature. The list on page 42 shows that for South Wales the number of species recognized is almost as great

as the number of specimens recorded; but, in spite of the recent increase in our knowledge of the coal measure insects, it is doubtful whether we have, or, indeed, ever shall have, anything like a true conception of the insect life of the coal forests. The explanation is simple: we have only to consider the result of a search to-day for dead insects among the debris of a forest. Such a search would reveal a few examples of several different kinds, and only under exceptional circumstances a great number of one kind at a particular site; at the same time those found would probably represent only a small proportion of the species living in the district. The discovery of many other orders is unlikely, because, of the modern insects, many are dependent on the existence of flowers which did not appear until long after carboniferous times, and many are parasitic upon animals of much later than carboniferous origin. M. E. M.

Neuroptera of Glamorgan.—H. M. Hallett ("The *Neuroptera* of Glamorgan," *Trans. Cardiff Naturalists' Soc.*, 1929, **62**, 67–75). Including the *Mecoptera*, the total number of British species amounts to 61, of which the county of Glamorgan has, so far, furnished 25. The author is of opinion that this number will probably be considerably increased when more interest is taken in these neglected groups. The species are listed under their respective families, and notes are given on their distribution and bionomics. M. E. M.

Biological Races of the Ermine Moth.—W. H. Thorpe ("Further Observations on the Biological Races in *Hyponomeuta padella* L.," *Journ. Linn. Soc.*, 1931, **37**, no. 254, 489-92). It has been shown previously that the small Ermine Moth (*Hyponomeuta padella* Linn. (*H. variabilis* Zell., *H. malinella* Zell.), is split into well-marked biological races—one attracted to the apple, and the other to the hawthorn, blackthorn, etc. Further evidence is now brought forward which suggests that the latter form is itself split into two less strongly marked subsidiary races, one attached to the blackthorn, the other to the hawthorn. M. E. M.

Malaria Transmission in the Philippines.—C. Manalang ("Malaria Transmission in the Philippines. II. Infection of *Anopheles funestus* (*Minimus*), with Notes on its Density, Probable Range of Flight, and Larval Control," *Philippine Journ. Sci.*, 1931, **45**, no. 3, 367–79, 1 text-fig.). The following is the author's summary. Data on *Anopheles funestus* caught in a human baited trap, in South Portal camp of Novaliches water project, show malarial infection to have been present in them throughout 1928 and eight months of 1929. The infection rates varied from 0·6 to 7·7 p.c. per month. The disturbance in infection rates due to movement of the population and to quininization is not known. Infections were not found when the catches were reduced to an average of 36 *funestus* per month during the nine negative months, while the average monthly catch during the twenty positive months was 338, and shows that malaria infection is mainly dependent upon *funestus* density. Disturbance in adult *funestus* density due to anti-larval measures is not known. Natural diminution in adult *funestus* density has been noted, and could not be attributed to larval extermination. Adult *funestus* catches in the trap is an effective index of the mosquito density, and reveals the efficiency of larval control, while malaria survey of those caught may be used to evaluate anti-malarial measures when the population is inconstant and periodical blood surveys prove unreliable. The flight range of *funestus* is probably more than 1·5 kilometres, the economic range of paris green control, and renders this method ineffective as a control measure. Trapping as a control measure is impractical and not effective. The number of larvæ breeding in a locality does

not necessarily indicate the adult density in the immediate vicinity of the human habitation. An adult mosquito survey, preferably by trapping, should be a part of the anopheles mosquito survey. M. E. M.

Philippine Tipulidæ.—C. P. ALEXANDER ("New or Little-Known *Tipulidæ* from the Philippines (Diptera), IX," *Philippine Journ. Sci.*, 1931, **45**, no. 3, 415–48, 3 pls.). The crane-flies discussed in the present report are chiefly from the La Lum Mountains, Davao District, Mindanao, Philippines, where they were collected at altitudes between 5,500 and 5,800 feet. A few of the species described from Mindanao were also found to occur in Luzon. The author herein gives descriptions of a large number of new species. M. E. M.

African and Malagasy Blattidæ.—J. A. G. REHN ("African and Malagasy Blattidæ (Orthoptera), Part 1," *Acad. Nat. Sci., Philadelphia*, 1931, **83**, 305–87, 5 pls., 4 text-figs.). The original incentive for the presentation of this series of contributions was the determination of certain collections of *Blattidæ* from Africa. Only a limited amount of study on the part of the author was necessary to show that the systematic background of our knowledge of African and, in fact, all Old World *Blattidæ* was superficial and misleading. The present part of these studies of African and Malagasy *Blattidæ* is made up of three sections: first, a revision of the Ethiopian species of the genus *Ectobius*, with a critical discussion on intra-sexual dimorphism as found in one of the species studied; second, the description of a new ectobine genus of aberrant character (*Xosablatta*), and the erection of a generic group to include the same; and, third, descriptions of four new species of as many subfamilies, which were treated in earlier studies and have been awaiting publication for some years, and now are presented to facilitate the work of other students. M. E. M.

Australian Diptera.—J. R. MALLOCH ("Notes on Australian Diptera, XXVII," *Proc. Linn. Soc., N.S.W.*, 1931, **56**, no. 234, 60–78, 2 text-figs.). The author here deals with new and existing species, genera, and subfamilies of the families *Chloropidæ*, *Milichiidæ*, and *Tachinidæ*. For the guidance of Australian students the author presents keys for the identification of the native species based upon Becker's descriptions and the new species herein described. M. E. M.

Life-History of Calliphora ochracea.—M. E. FULLER ("The Life-History of *Calliphora ochracea* Schiner. (Diptera, Calliphoridæ)," *Proc. Linn. Soc., N.S.W.*, 1931, **56**, pt. 3, no, 235, 172–81, 2 text-figs.). The earliest reference to *Calliphora ochracea*, other than purely systematic, occurs in the pamphlet by W. W. Froggart, published in 1914. His attempts to breed the species in captivity were unsuccessful, as likewise were those of Hardy in 1926. Under insectary conditions the author has induced the fly to breed, and the present paper gives the life-history and description of the various stages. An interesting feature of this work lies in the fact that *C. ochracea*, although very distinctive in the adult stage, is remarkably like other *Calliphoridæ* in the earlier stages. Unfortunately, no indication has been gained of the breeding habits in nature. M. E. M.

Blueberry and Huckleberry Insects.—C. R. PHIPPS ("Blueberry and Huckleberry Insects," *Maine Agric. Exper. Station*, 1930, Bull. 356, 107–232, figs. 16–24). This paper is based on a five years' study of the insects which feed upon or otherwise affect the various species of blueberry and huckleberry occurring in Maine. It also includes records of some insects collected by the writer on these plants in Massachusetts. In addition, it attempts to list those insects which other

investigators have reported as destructive to the group of plants. For convenience the mites which infest these plants are also included. During the course of this study the writer has taken, on blueberry and huckleberry, some 80 different species of insects previously unrecorded as visitants. Many of these insects cause considerable damage, especially the cut-worms, loopers, sawflies, and a species of thrips new to science. M. E. M.

New and Little-Known Ants.—W. M. Wheeler ("New and Little-Known Ants of the genera *Macromischa*, *Cræsomyrmex* and *Antillæmyrmex*," *Bull. Mus. Comp. Zool., Harvard Coll.*, 1931, **72**, no. 1.) With recent accessions, the genus *Macromischa*, as defined by Rogers and emended by Mann, now comprises 54 forms (43 species, 3 subspecies, and 8 varieties). The author discusses the characteristics of the genera in question, and concludes that we may assume, therefore, that the nearest allies of the *Macromischa* were already developed in northern Europe as early as the Lower Oligocene. The derivation of the Antillean genera *Macromischa*, *Cræsomyrmex*, and *Antillæmyrmex* may be regarded as from some offshoot of the circumpolar genus *Leptothorax*, a large and heterogeneous complex which has also given rise to the present almost entirely continental neotropical subgenus *Goniothorax*. There is an alternative interpretation, however, namely, that the three neotropical genera *Macromischa*, *Cræsomyrmex*, and *Antillæmyrmex* are directly derived from the *rottenbergi* group of *Leptothorax*, but this would necessitate for either a hypothetical sunken land-bridge between the Mediterranean region and the Antilles, as suggested by Scharff, or an early geological apposition of the Antillean region and the north-west of Africa, as postulated by Wegener. M. E. M.

Biology and Morphology of Eurymelinæ.—J. W. Evans ("Notes on the Biology and Morphology of the *Eurymelinæ* (Cicadelloidea, Homoptera)," *Proc. Linn. Soc., N.S.W.*, 1931, **56**, pt. 3, no. 235, 210–26, 1 pl., 19 text-figs.). The *Eurymelinæ*, which comprises a group of insects entirely confined to Australia and the neighbouring islands, has, up to the present time, been regarded as a division of the *Bythoscopidæ*, owing to the facial position of the ocelli, though it differs from the true members of that family in possessing broad, flap-like subgenital plates with apical spine-like styles, quite distinct from the narrow plates found in the *Bythoscopidæ*. Under the section on the life-history the author deals with the oviposition, hatching, nymphal instars and feeding habits. There is a short discussion on the relationship with ants, and a description is given of the natural enemies so far encountered. Except for the fact that tender shoots of the eucalyptus are occasionally attacked by the nymphs, these insects are not considered to have any economic importance, at least in Australia. The latter part of the paper is concerned with the external and internal anatomy of the *Eurymelinæ*. M. E. M.

Australian Trichopterygidæ.—C. Deane ("*Trichopterygidæ* of Australia and Adjacent Islands," *Proc. Linn. Soc., N.S.W.*, 1931, **56**, pt. 3, no. 235, 227–42, 23 text-figs.). In this second paper on the *Trichopterygidæ*, by the same author, 20 new species are described under 10 genera, five of the latter being new.
M. E. M.

New Sand Flies.—C. Manalang ("Three New Sand Flies from the Philippines," *Philippine Journ. Sci.*, 1931, **45**, no. 3, 355–65, 3 text-figs.). The three species of sand flies are recumbent-haired types, while their males have the *minutus* form of genitalia. As far as can be ascertained, they possess a combination of characters different from those already described for sand flies from the Philippines and other oriental countries. The descriptions of the three new species, under the

names *Phlebotomus bigtii* n.sp., *P. dayapensis* n. sp., *P. torrechantei* n. sp., are based entirely on potash preparations mounted in Berlese's fluid. The spermatheca are not described, as they were not shown clearly in the preparations. M. E. M.

Insect Mimicry.—E. B. POULTON ("Two Specially Significant Examples of Insect Mimicry," *Trans. Entom. Soc., Lond.*, 1931, **79**, pt. II, 395–8, 2 pls.). The examples discussed are, first, the case of *Papilio laglaizei*, which has two separate halves of a red area, one on each of the under-surfaces of the hind wings, which, when the wings are brought together, form a single red area. The suggestion is advanced that this is a mimetic resemblance to the red marking on the underside of the abdomen of the Uraniid moth *Alcidis agathyrsus*. The second example relates to the distribution of the cocoons of an Ichneumonid on the cocoons of the Bombycid moth *Norasuma kolga* with intent to resemble parasitism by Braconids. M. E. M.

New Chrysomelidæ.—S. MAULIK ("No. IX. *Coleoptera, Chrysomelidæ; Eumolpinæ, Galerucinæ*, and *Halticinæ*," *Trans. Linn. Soc., Lond.*, 1931, **19**, pt. 2, 2nd ser., Zool., 241–60, 13 text-figs.). The present paper deals with the subfamilies *Eumolpinæ, Galerucinæ* and *Halticinæ* of the family *Chrysomelidæ*, brought back by the Percy Sladen Trust Expedition to the Indian Ocean in 1905 and 1908–9. It describes 16 species, of which only one is referable to a known species, and the rest are new. Four new genera are erected. Remarks on interesting points regarding structure, variation, and distribution are included in the paper. M. E. M.

Platyhelminthes.

Trematoda.

The Germ Cell Cycle in the Trematode Family Bucephalidæ.—ARTHUR E. WOODHEAD (*Trans. Amer. Micro. Soc.*, 1931, **50**, 169–88, 5 pls.). A redia stage in the development of Gasterostomes is here described for the first time and figured. The author believes that there are three adults, the Gasterostome being polymorphic and bi-sexual, each of the three generations having homologous stages, and he describes spermatogenesis in the mother sporocyst, the redia, and the final adult. There appears to be no parthenogenesis or metagenesis, each generation beginning with a fertilized egg, and reproduction and fertilization occurring in each generation. Three species of Gasterostomes were used in this study—*Bucephalus elegans*, *B. papillosus*, and *B. pusillus*. Both living and stained and mounted preparations of sporocysts and redia were studied, as well as serial sections of the parasitized clams. J. L.

The Evolution of the Excretory System in Certain Groups of the Furcocercous Cercariæ.—R. B. SEYMOUR SEWELL (*Rec. Ind. Mus.*, 1930, **32**, 357–83, 4 pls., 2 figs.). It is suggested that the usual line of development occurs by and through successive division of individual pairs of flame-cells. In the series of forms examined by the author, the primitive form—the starting-point for the several lines of evolution among the furcocercous cercariæ—appeared to be that in which there were four flame-cells on each side of the body, three in the body and the fourth in the tail-stem. These were so arranged that two opened into the anterior collecting duct, and two into the posterior. Single-paired and two-pair flame-cell systems occurred only in certain miracidia. Evolution is first traced in

two groups of the Apharyngeal Brevifurcate Distomes—those having eyes and those in which eyes are absent. The cercariæ of the true Schistosomes show the primitive condition in the latter group, but there was as yet no known representative of the corresponding condition in the first group. In the evolution of these forms there was a tendency for the anterior daughter-cell produced by division of the tail flame-cell to migrate into the body. Similar evolutionary processes are next described for the Pharyngeal Longifurcate Distomes, which include the Strigeid cercariæ. These forms the author divides into those having a cross-connection between the main excretory tubes, the "Strigea" series, and those in which such a connection is lacking, the "Proalaria" series. In both these groups no form was known which represented the primitive condition. A third line of evolution was traced in "Group III." This contained the forms which had, according to Faust, three, four or five basic groups of two flame-cells each, but it was shown that these could have arisen from the primitive four-flame cell system, and, as the excretory tubes were unconnected, would appear to be connected with the "Proalaria" group. When the evolution is traced, however, it is found that the order of division appears to be different from the Longifurcate Distomes. J. L.

Life-History Studies on Two Frog Lung-Flukes Pneumonœces medioplexus and Pneumobites parviplexus.—Wendell H. Krull (*Trans. Amer. Micr. Soc.*, 1931, **50**, 215–77, 2 pls.). This experimental study, here fully recorded, has elucidated the complete life-cycle of the two frog lung-flukes. *Pneumonœces medioplexus*, from *Rana pipiens*, was found to undergo development first in *Planobula armigera*, and secondly in *Sympetrum obtrusum* and *S. rubicundulum*, while the corresponding intermediate hosts for *Pneumobites parviplexus*, from *Rana clamitans*, were *Gyraulus parvus*, *S. obtrusum*, and *S. rubicundulum*. The former life-cycle was complete in two months, but the latter took rather longer. The eggs hatched in the digestive system of the snails, cercaria being produced on or after the thirty-second day. Entrance to the rectal respiratory chamber of the dragon-fly nymph was passive, and encystment occurred in the tissue of the branchial basket. Metacercariæ were fully grown in 14–15 days, as many as 220 metacercariæ being found in a single naturally infected Sympetrum. Of the larval stages, only the metacercariæ of the two species could be distinguished from one another. Maturation in the frog required a month. A natural infection of 74 mature worms was the largest number obtained in a single frog. Tadpoles were not naturally, and could not be experimentally, infected with matacercariæ.

J. L.

Nemathelminthes.

Nematoda.

Precipitin and Complement Fixation Tests on Dog Sera with Antigen from the Dog Hookworm, Ancylostoma caninum.—J. E. Stumberg (*Amer. Journ. Hyg.*, 1930, **12**, 657–68). The antigens used were dried filariform larvæ and adults of *Ancylostoma caninum* extracted with acid and alkaline saline solutions (the latter being preferable). When intravenously injected into rabbits, it was found that the adult antigen produced a higher titre than the larval antigen. Antibodies produced in immunized rabbits were species specific in dilutions of 1 : 400 or over, group specific in dilutions of 1 : 1,000 to 1 : 4,000. Antigens prepared from other intestinal helminths gave non-specific reactions, but never in dilutions of over 1 : 1,000, and usually of only 1 : 100. Dog serum showed

a non-specific, complement-fixation titre with these antigens as high as 1 : 500, a reaction undestroyed by heating to 62° C. for half an hour, but parenteral injection failed to show either precipitins or complement-fixation in excess of the non-specific level. Dogs experimentally infected with hookworm showed no anti-bodies in their sera up to seven weeks after infestation. J. L.

A Study of the Relation of the Dry Season to the Level of Helminth Infestation in a Panama Village.—LOUIS SCHAPIRO and W. W. CORT (*Amer Journ. Hyg.*, 1930, **12**, 699–708). This study was made in Dolega, Chiriqui Province, Panama, a region of high annual rainfall and densely shaded yards. A preliminary examination showed a heavy Hookworm infestation, a rather low Ascari count, and an extremely heavy Trichuris infestation. By the dilution egg-counting method, two series of counts of 100 individuals were made about two months after the end of the rainy season, and again after the end of the dry season. The latter showed an increase for all three infections, although this was due to a great increase in a very small number of cases, indicating that there was no reduction in the helminth infestation during the dry season. J. L.

The Egg Production of Two Physiological Strains of the Dog Hookworm, Ancylostoma caninum.—O. R. MCCOY (*Amer. Journ. Hyg.*, 1931, **14**, 194–202). Larvæ for infection were obtained, by the Baermann technic, from cultures of the fæces of cats and dogs, infected each with their respective strain of *Ancylostoma caninum.* When the animals became positive, egg counts were made from fæcal samples collected over a period of three days, and the number of eggs passed per day calculated. It was found that whereas the normal egg production of the cat strain of *Ancylostoma caninum* in the cat was 2,350 eggs per day per female, the same strain in dogs produced 11,600 eggs per day per female. The dog strain in the dog normally produced 18,000 eggs per day per female, but in the cat only 2,340 eggs per day. Thus egg production appeared to be controlled by the host and not to be inherent in the strain of worms. J. L.

Observations on the Rate of Loss of Necator americanus.—G. C. PAYNE and F. K. PAYNE (*Amer. Journ. Hyg.*, 1931, **14**, 149–55). The daily loss of worms was studied in three patients, a 3-gram sample of each stool being taken for an egg count, and the remainder sieved and searched for adult worms. The observed apparently spontaneous loss is shown, in the tables given, to be considerably less than the theoretical loss calculated according to Chandler's estimates, but was nevertheless observable in each patient. J. L.

Central Bodies in the Sperm-Forming Divisions of Ascaris.—HARWELL P. STURDIVANT (*Science*, 1931, **73**, no. 1894, 417–18). It has been recently contended that in the sperm-forming divisions of Ascaris the centriole is primarily a blepharoplast for the production of the axial filament of the sperm tail, and only secondarily associated with the astral centres. Accordingly, a re-investigation was undertaken by the author, using, as a crucial test for the above interpretation, *Ascaris megalocephala*, where the mature sperm had neither tail nor axial filament. His results clearly showed that there was no ground for considering the centrioles as differing in any material way from those seen in the mitosis of other cells. A fuller account was in preparation. J. L.

New Trematodes from the Subantarctic and Antarctic.—T. HARVEY JOHNSTON (*Austral. Journ. Exper. Biol. & Med. Sci.*, 1931, **8**, 91–8, 4 figs.). A preliminary account is given of the ecto-parasitic Trematode *Pseudobenedenia*

nototheniæ n.g., n. sp. This is based on material obtained from the fish *Notothenia angustata* and *N. colbecki*, from Antipodes Island, by Prof. W. B. Benham in 1907, and from *Notothenia macrocephala*, at Macquarie Island, by the Australian Antarctic Expedition. Specimens of Trematodes from the intestine of Weddell seals, and identified as *Osmogaster plicata*, are considered by the author to differ from *O. plicata* from northern whales on several points, and are here redescribed as a new species. J. L.

A Survey of Mysore State for Hookworm and Other Helminthic Infestations.—W. C. Sweet (*Mysore Dept. Health*, 1929, Bull no. 7, 1–53, 11 figs.). This survey was undertaken during the months July, 1927, to October, 1928. During the first four months of this period a preliminary examination of prisoners, students and patients was made, and later the more detailed study of the district conditions. In this the average condition of the population of the area was sought, and as far as possible made representative as to sex, age, and occupation. Altogether 11,972 persons were examined, and the following were the infections identified :—59·4 p.c. Hookworm (*Necator americanus*), 34·2 p.c. *Ascaris lumbricoides*, 14·1 p.c. *Trichuris trichiura*, 2·6 p.c. *Oxyuris vermicularis*, 1 p.c. *Hymenolepis nana*, 0·4 p.c. *Trichostrongylus* sp. (though this was probably often mistaken for Hookworm), *Tænia* sp. 6 times only, and *Hymenolepis diminuta* only once. The incidence of the Hookworm infections did not vary very much between the different areas in any district, while the incidence of Ascaris was very patchy. Statistics are given showing the average intensity of each of the major infections, and according to age, sex and occupation; also the average number of eggs per c.c. according to age and sex. An investigation in regard to the relation of rainfall to these three infections showed " that there was no essential difference in Mysore in relation to rainfall, yearly or monthly, of incidence or intensity, per person examined or person infected, of the three parasites." It was probable, however, that Trichuris was able to spread in areas of lower rainfall than Hookworms. J. L.

Parasitic Nematodes from Animals Dying in the Calcutta Zoological Gardens.—P. A. Maplestone (*Rec. Ind. Mus.*, 1930, **32**, 385–412, 38 figs.). Part I deals with Nematodes from the Gharial (*Gavialis gangeticus*). Five species are described and figured, and include a new genus and species, *Polycæcum gangeticum* (of which only one immature female was found), and a new species of Gœzia. The material for Part II consists of three genera and one new species of the subfamily Amidostominæ. Part III is entitled " Notes on the genera Habronema Diesing, 1861, and Cyrnea Seurat, 1914." After a discussion of the differentiation of these two genera, three species of Habronema are described and figured. Two of these are new to science. J. L.

Quantitative Studies on the Administration of Variable Numbers of Nematode Eggs (Ascaridea lineata) to Chickens.—James E. Ackert, G. L. Graham, L. O. Nolo, and D. A. Porter (*Trans. Amer. Micr. Soc.*, 1931, **50**, 206–14). Feeding experiments were made with 628 chickens. It was found that feeding with 500, 300, or with 100 eggs made little difference to the size of infestation produced, probably owing to fluctuations in the hatching rate of the eggs, and in rate and vigour of the peristaltic movements of the fowls' intestines. Both percentage of survival of the larvæ and their growth rate were decreased by feeding with large egg doses, and this was attributed to a seriological inhibiting factor. At ten weeks old chicks were more resistant to the viability and growth of *Ascaridea lineata* than at seven and six weeks old. J. L.

Rotifera.

A Winter-Loving Rotifer from Hungary.—L. VARGA (Sopron) ("*Rhinops fertöensis*, ein neues Rädertier aus dem Fertö (Neusiedlersee)," *Zool. Anz.*, 1929, **80**, 236–53, 6 text-figs.). The author publishes, under the generic name given in title, a very thorough and careful account of a second species of the genus Rhinoglena of Ehrenberg, which he has found during three successive winters in the great Neusiedl Lake ("Fertö" in Hungarian) in the west of Hungary. There is a considerable difference in the appearance of the new form as compared with that of the species which one is accustomed to see in England. It is much less graceful in outline, the so-called proboscis is less prominent, the trunk is proportionately longer, sack-like, cylindrical, and suddenly truncate, while the foot is very small and usually hidden. It is fully twice as large as *Rhinoglena frontalis*, and, like that species, swims slowly and gracefully. It is purely a plankton form, never coming near the shores, but keeping well out in the deeper water of the lake, differing in this from the earlier known species, which may be found in quite small ponds and near to the shore. Above all, it is peculiar in appearing to be limited to a short winter season, November to March inclusive. Both sexes have come under observation, and many interesting details of their relations are set forth. The males are exceptionally large for that sex among rotifers, as large, indeed, as the females of the more widely distributed species, and, as in that form, they are provided with jaws and stomach which have been observed to function. They do not appear until February or perhaps March. The females are either amictic or mictic. Amictic females are hatched out at the beginning of each season from resting eggs of the preceding, and begin parthenogenetic reproduction of living young. At first the progeny are all amictic females, but after several generations a proportion of larger and mictic females appear, and these, if unfecundated, produce living males, or, if fecundated, produce resting eggs, which, so far as is yet known, do not seem to be dropped, but remain in the body of the parent until after her death. In the later months of the season a few of the mictic females attain the great size of 800 to 850μ, and in some cases contain in their bodies as many as six embryos. The author thinks that this form may be supposed to be a relict from glacial times. D. L. B.

Protozoa.

Cultivation of Endamœba coli.—M. TANABE and N. KUWABARA ("Studies on the Growth of *Entamœba coli* in vitro," *Keijo J. Med.*, 1931, 2, 199–207). The authors have tested the effect of varying the constituents of the fluid part of Tanabe and Chiba's medium upon the development of *Endamœba coli*. The solid part of the medium consists of agar slants made with Ringer's solution, 10 gm. agar, 1 gm. asparagin. The medium is covered to the height of the slant with Ringer's solution containing rabbit or horse serum. When peptone is added, the amœbæ do not grow. Cholesterol has a good effect upon their growth. They also grow well in a medium the fluid part of which is composed of cholesterol 0·001 gm., peptone 0·3 gm., Ringer's solution 100 cc. C. A. H.

Cultivation of the Pig Amœba.—N. KUWABARA ("On the Cultivation of *Entamœba polecki* (Prowazek, 1912) in vitro," *Keijo J. Med.*, 1931, 2, 272–6). Cysts of *Endamœba polecki* obtained from the cæcum of the domestic pig were cultivated in Tanabe and Chiba's medium (*see* Tanabe and Kuwabara's paper). In this medium they grow well at 37° C., persisting for over six months, and encyst readily. C. A. H.

Effect of Diet upon Termite Flagellates.—E. E. LUND ("The Effect of Diet upon the Intestinal Fauna of *Termopsis*," *Univ. Calif. Pub. Zool.*, 1930, **36**, 81–96, 14 figs.). Experiments were conducted to determine whether the intestinal flagellates of the termite *Termopsis* sp., which normally feed on cellulose ingested by the host, are capable of living on the lower carbohydrates, the starches, and sugars. It was found that the proportion of the flagellates present could be varied by changing the diet of the host. The protozoa were able to assimilate the higher carbohydrates, trisaccharides to starches, but only survived longer than in starved termites. If a soluble diet was used, disaccharides and monosaccharides, the protozoa died quickly. C. A. H.

Coccidia of the Pig.—D. P. HENRY ("A Study of the Species of *Eimeria* occurring in Swine," *Univ. Calif. Pub. Zool.*, 1931, **36**, 115–26, 2 pls.). Description of coccidia of the genus *Eimeria* from the domestic pig in California. In addition to *E. debliecki*, the only form hitherto known, three new species are recorded. *E. scabra* sp. n.: oocyst wall brown, with rough surface. Size of oocysts 22·4–35·6μ × 16·0–25·6μ. Sporocysts measure 16–19·2μ × 6·4μ; when fully developed, a residual body is present. *E. perminuta* sp. n.: oval or spherical oocysts measuring 11·2–16·0μ × 9·6–12·8μ. *E. spinosa* sp. n: oocysts brown in colour, the wall studded with spines. Dimensions 16·0–22·4μ × 12·8–16·0μ. The sporocysts of this species measure 9·1–11·7μ × 5·2–6·5μ, and contain a large residual body. C. A. H.

New Flagellates from Termites.—V. E. BROWN ("Hypermastigote Flagellates from the Termite *Reticulitermes: Torquenympha octoplus* gen. nov., sp. nov., and Two New Species of *Microjœnia*," *Univ. Calif. Pub. Zool.*, 1930, **36**, 67–80, 2 pls.). New hypermastigote flagellates from the intestine of termites of the genus *Reticulitermes*. *Torquenympha octoplus* gen. n., sp. n.: a radially symmetrical, small flagellate, with a pear-shaped body (11 × 20μ). Neuromotor apparatus consists of about 16 long anterior flagella, rhizoplast, centroblepharoplast, stout axostyle, ring of 8 rounded parabasal bodies. The centroblepharoplast has a flattened, deeply staining cap; there is a single anterior nucleus. Two new species of *Microjœnia*, *M. ratcliffei* and *M. pyriformis* spp. n., are described. *Microjœnia* is considered to be a valid genus and not a part of the life-cycle of *Spirotrichonympha*. C. A. H.

Conjugation in Paramæcium.—E. CHATTON and M. CHATTON ("La conjugaison du *Paramœcium caudatum* determiné expérimentalement par modification de la flore bactérienne associé. Races dites conjugantes et non conjugantes," *C. R. Acad. Sci.*, 1931, **193**, 206–8). A "wild" strain of *Paramœcium caudatum* was separated from the bacteria accompanying it, and the ciliates were grown with pure and mixed cultures of about five different varieties of bacteria. The object was to determine whether the presence of bacteria had any effect in inducing the ciliates to conjugate. A pure culture of a bacterium (*u*1) was obtained, in which the sexual phenomenon regularly occurred, while with other bacterial strains conjugation was not observed. However, if these paramæcia were transferred to the culture of *u*1, conjugation took place. According to the authors, the peculiarities of some of the conjugating and non-conjugating races of ciliates are not due to their genetic constitution, but to the influence upon them of the kind of the bacteria with which they are associated. C. A. H.

A Ciliate Parasitic in a Mollusc.—D. L. MACKINNON and H. N. RAY ("Notes on the Ciliate *Boveria stevensi* Issel from *Galeomma turtoni* Sowerby at

Plymouth," *Journ. Marine Biol. Assn.*, 1931, **17**, 577–82, 2 figs.). A morphological study of *Boveria stevensi*, a ciliate found in the gills and mantle cavity of a lamellibranch mollusc, *Galeomma turtoni*, at Plymouth. The following characters are specially noted: the ventral lines of cilia converge, at an acute angle, a short distance behind the aboral end. The oral end is surrounded by a double row of long, stout cilia; these are arranged along a line following a right-handed spiral. The systematic position of *Boveria* is uncertain: it is regarded by some as a holotrichan, by others as a heterotrichan, but the authors are inclined to the view that it is related to the Peritricha. C. A. H.

Parasitic Amœba from an Ascidian.—D. L. MACKINNON and H. N. RAY ("An Amœba from the Intestine of an Ascidian at Plymouth," *Journ. Marine Biol. Assn.*, 1931, **17**, 583–6, 3 figs.). An amœba was found parasitic in the intestine of an ascidian, *Phallusia mamillata*, at Plymouth. The amœba, when fully extended, measures about 15–30μ × 10–15μ. It forms a "sole" like pseudopodium upon which the main part of the body rests. The nucleus has an eccentric karyosome and chromatin granules on the periphery. The amœba is named *Entamœba phallusiæ* sp. n. C. A. H.

Ciliates from an Indian Frog.—F. DE MELLO ("Infusoires parasites de *Racophorus maculatus* Gray," *Arq. Esc. Méd.-Cirurg. Nova Goa* (*A*), 1931, **6**, 951–7, 1 pl.). Description of some ciliates found in the intestine of an Indian frog, *Rhacophorus maculatus*. Some of these are identical with forms described previously (*Nyctotherus papillatus*, *Opalina virgula*, *Cepedea longa*). One ciliate proved to be a new species, *Cepedea thiagi* sp. n. A key is provided for the identification of the Opalinidæ found in the frog. C. A. H.

New Ciliates.—C. C. WANG ("On Two New Ciliates (*Holophrya latericollaris* sp. nov. and *Choanostoma pingi* gen. and sp. nov.)," *Contrib. Biol. Lab. Sci. Soc., China*, 1930, **6**, 105–11, 5 figs.). Description of two new ciliates from a pond in Nanking. *Holophrya latericollaris* sp. n. is about 45μ long. Its cytostome is oval and, unlike that of most of the other species of the genus, is situated subterminally and is surrounded by a collar-like projection. Body ovate, obliquely striated. *Choanostoma pingi* gen. n., sp. n., has a subspherical body, measuring, on the average, 42μ in length. An annular constriction at the anterior pole divides it into a smaller, non-ciliated portion, the "collar," and a large ciliated portion of the body proper. Cytostome terminal, in the middle of the collar. Long and pointed cirri, given off from the annular girdle, form a wreath around the collar. Macronucleus beaded. Single contractile vacuole. *Choanostoma* belongs to the holotrichous family Enchelinidæ. C. A. H.

Coccidia of Gallinaceous Birds.—D. P. HENRY ("Species of Coccidia in Chickens and Quail in California," *Univ. Calif. Pub. Zool.*, 1931, **36**, 157-70, 2 pls.). The author records the four species of *Eimeria* described by Tyzzer from Californian fowls. Three of these also occur in quail. In a note on the method of preserving the sporulating phases of the coccidia, 2·5 p.c. solution of potassium bichromate is said to give the best results. C. A. H.

New Tertiary Foraminifera.—J. A. CUSHMAN and ALVA C. ELLISON ("Some New Tertiary Foraminifera from Texas," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 107, 51–8, figs. 1–11 on pl. 7). The authors describe and figure eight new species and three new varieties from the Lower Oligocene and Upper Eocene of

Texas. It is stated that they all have characters distinguishing them from related forms, and that they have definite ranges which make them suitable for stratigraphic work. A. E.

New Species.—J. A. Cushman ("Three New Upper Eocene Foraminifera," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 108, 58–9, figs 12–14 on pl. 7). The three species *Nonionella hantkeni*, *Discorbis hemisphærica* and *Cibicides yazooensis* are, for particular reasons, described and figured in anticipation of the publication, by the U.S. Geological Survey, of a large report by the author on the "Upper Eocene Foraminifera of the Coastal Plain of the United States." A. E.

A New Plectofrondicularia.—J. A. Cushman and Gerald M. Ponton ("A New *Plectofrondicularia* from Florida," *Cont. Cush. Lab. Foram. Res.*, 1931, no. 109, 60–2, fig. 1 on pl. 8). The new species *P. mansfieldi* is quite distinct from *P. floridana* Cushman, already known from the Miocene of Florida, the sides being truncate and concave, while in *P. floridana* there is a distinct and high median keel in addition to the two side-keels. The sutures also are much more curved and not limbate, and the chambers higher in the new species. A. E.

The Species Named by Batsch, 1791.—J. A. Cushman ("Notes on the Foraminifera Described by Batsch in 1791," *Cont. Cush. Lab. Foram. Res.*, no. 110, 62–72, figs. 2–24 on pls. 8 & 9). The "Sechs Kupfertafeln mit Conchylien des Seesandes," published in 1791, is the first work of importance in defining the specific names of foraminifera subsequent to Linné and Gmelin, and it is therefore imperative to fix definitely, if possible, what the organisms of Batsch were. Fortunately, his figures are good, and although he gives no information as to the sources of his material, it is probable that the specimens were recent and from Rimini or other Adriatic locality. Most of his species are to be found in shore sands from Rimini, which provided material for many of the early authors. The identification of Batsch's species has already been undertaken by Parker, Jones and Brady in 1865, but their work was probably based on a review of the literature more than upon a comparative study of specimens from type localities. Batsch's book is very rare, and seems to have attracted little attention, with the result that his species have been given other names by subsequent authors, including Soldani, Fichtel and Moll, Defrance and d'Orbigny, who all worked on material from Rimini. In later years Fornasini published many notes on the foraminifera of the same locality. In Cushman's very valuable paper the descriptive notes of Parker, Jones and Brady are copied and followed by criticism of the characters of Batsch's species as observed in material collected by the author at Rimini in 1927. There is no attempt to give a detailed synonomy, but many useful references to later names are given. Drawings of typical specimens from Rimini which seem to be identical with Batsch's figures add value to the paper.
A. E.

Miocene of California.—J. A. Cushman and B. Laiming ("Miocene Foraminifera from Los Sauces Creek, Ventura County, California," *Journ. Palæont.*, 1931, 5, no. 2, 79–120, pls. 9–14, 5 text plans and tables). Descriptions and figures of 68 species of foraminifera, including 10 new species and six new varieties, from the "Temblor clay shale" which overlies the oil-bearing Vaqueros sandstone in the Santa Barbara coastal region of California. The foraminifera were obtained from a series of samples collected at rather regular intervals throughout the 2,000 feet of clay shale continuously exposed in a southern dipping monocline along Los

Sauces Creek. The distribution and range of the species are shown in a check list, and the faunal zones are indicated in the list, in sections and in a map of the area. Comparisons are also made between the zonal assemblages represented in this section and those found in Temblor and Vaqueros strata of several other localities. The paper is admirably illustrated. A. E.

Miocene of Egypt and Sinai.—W. A. MACFADYEN ("Miocene Foraminifera from the Clysmic Area of Egypt and Sinai, with an Account of the Stratigraphy and a Correlation of the Local Miocene Succession," *Survey of Egypt—Geological Survey, Government Press, Cairo, 1*930 (published May, 1931), i–vi, 1–149, pls. 1–4, map of area and geological map in folder). This is one of the most important papers of its kind published in English for many years, though it has suffered in value from delay in publication, the field work on which it is based having been carried out between 1920–2 and the manuscript completed in 1927, since when it has not been possible to bring it up to date. The first part (26 pages) is purely geological, and deals, not only with the sections examined in the Egyptian area, but also with their correlation with other areas of the Miocene Mediterranean Sea. The second part (pp. 27–138), dealing with the foraminifera, includes a *résumé* of previous work in Egypt and neighbouring areas, a comparison of the foraminiferal faunas of Rhodes, Cyprus and Egypt, and details of the samples examined. There is evidence of a change of fauna in the course of deposition of the deposits, due, apparently, not to a change of climate, but to a considerable tectonic disturbance which brought about a sudden rise of 200 fathoms or more in the Miocene sea floor, which in turn probably brought about an alteration in the surface currents. This would account for the presence of some pelagic species among the shallow-water forms. There is a systematic description with synonymies of the 185 species and varieties recorded, including five new species and varieties, their distribution and frequency being shown in tabular form. A very useful "Note on *Bolivina* (*sensu lato*), with a Key to the Genus," is given in an appendix with a list of all the species described up to June 1927. This should be extremely valuable to future workers. The plates are good. A. E.

Atlantic Foraminifera.—J. A. CUSHMAN ("The Foraminifera of the Atlantic Ocean. Part 8. Rotaliidæ, Amphisteginidæ, Calcarinidæ, Cymbaloporettidæ, Globorotaliidæ, Anomalinidæ, Planorbulinidæ, Rupertiidæ and Homotremidæ," *Smithsonian Inst., U.S. Nat. Mus.*, Bull. 104, 1931, i–ix, 1–179, pls. 1–26). The issue of this part concludes a monumental work which was commenced so long ago as 1918. Since then much work has been done, and the monograph has suffered to some extent from the delay in publication, and perhaps still more from the abandonment of the original scheme of classification for the new scheme of the compiler. The change-over was made in 1929, when the parts already published were briefly revised. In a work of this nature, largely based on earlier publications, there are bound to be omissions, but, apart from the dismissal of many recorded species with a mere note that the published figures are unsatisfactory, such omissions are surprisingly few. The author's pronounced views on the rigidity of specific characters in the foraminifera and the general limitation of species to particular areas are well known. They are not stressed so much in this last section as in some of its predecessors, only four new species and five new varieties being described. The plates are excellent and greatly in advance of some of the earlier sections of the work. The publication will be of the greatest value to future students.

A. E.

Tertiary of Somaliland.—W. L. F. Nuttall and A. G. Brighton ("Larger Foraminifera from the Tertiary of Somaliland," *Geol. Mag.*, 1931, **68**, no. 800, 49–65, pls. 1–4, 3 text-figs.). Describes a small collection of specimens made in the course of a survey by the Anglo-Italian Boundary Commission of Somaliland in 1929–30. The fauna is of value in determining the age of the beds, and the geographical range of several species is extended. Thirteen species and varieties in all are described, three of the species being new, the most interesting being a new species of the little-known genus *Linderina*, the other two being *Nummulites* related to Middle Eocene species. The paper is well illustrated. A. E.

Plymouth Marine Fauna.—(*Second Edition*, 1931. *Being Notes of the Local Distribution of Species occurring in the Neighbourhood. Compiled from the records of the Laboratory of the Marine Biological Association, order Foraminifera*, pp. 34–50). The list of species is compiled from the papers by R. H. Worth, *Journ. Marine Biol. Assn.*, 1904, vol. vii, p. 155, and E. Heron-Allen and A. Earland in *Journ. Roy. Micr. Soc.*, 1930, 46–84 and 161–99. A. E.

BOTANY.

(*Under the direction of* A. B. Rendle, D.Sc., F.R.S.)

GENERAL.

Cytology.

Histology and Cytology of the Taxus Aril.—J. Lebensbaumówna (" Quelques détails concernant l'hystologie et la cytologie de l'arille du *Taxus baccata*," *Acta Soc. Bot. Poloniæ*, 1930, **7**, 311–28, Polish with French summary). The development of the aril of *Taxus baccata* is described, together with changes observed during ripening and cellular degeneration. Growth of tracheids, the occurrence of tannin vacuoles and fat globules, changes in leucoplasts and chloroplasts and the accumulation of red droplets of rhodoxanthine are figured and recorded. Nuclear degeneration is also described: it is found to commence at the base and to proceed towards the epidermis until the entire aril becomes mucilaginous. J. L.

Hybrid Fertility in Quercus.—H. J. Sax (" Chromosome Numbers in *Quercus*," *Journ. Arnold Aboretum*, 1930, **11**, 220–3). Pure species and known hybrids of *Quercus* from the Arnold Arboretum were studied cytologically to determine chromosome numbers, size, and percentage sterility of the pollen grains. A table is appended giving these results, together with geographic distribution in 8 species of subgenus *Erythrobalanus* and 20 species and hybrids of the subgenus *Lepidobalanus*. In all cases the chromosome number $= 12 \pm 1$. There is a striking uniformity in the pollen fertility of pure species and hybrids. Size of pollen grain also only varies slightly. The author shows that among the oaks great variability in morphological characters and wide geographical distribution are linked with uniformity in chromosome number and pollen fertility—even among hybrids. J. L.

Tetraploidy in Euphorbia sp.—H. H. Harrison (" Some Peculiarities in the Chromosome Behaviour of *Euphorbia terracina*," *Proc. Univ. Durham Phil. Soc.*, 1930, **8**, 252–9). During somatic metaphase in the cells of the root-tip of *Euphorbia terracina* 18 similar chromosomes occur. These are usually linked in pairs, either end to end or by a long chromatin thread. In tetraploid tissue 4 similar chromosomes are thus linked. The author suggests that these are duplicated homologues. The origin of polyploidy and the possibility of actual reduction divisions in this somatic tissue are discussed. J. L.

Sterility in Roses.—E. W. Erlanson (" Sterility in Wild Roses and in Some Species Hybrids," *Genetics*, 1931, **16**, 75–96). Pollen from more than 360 individual wild rose plants is examined for sterility, and the results compared with the percentage sterility in artificially produced interspecific hybrids. The percentage

of ovule sterility in 14 species of rose is compared with zygotic and pollen sterility; seasonal variation in pollen sterility of individual plants is recorded. On analysis the present results do not support the views of Hurst (1925, 1928), and the degree of sterility alone is not found to give valid evidence for or against hybridity. J. L.

Chromosome Morphology in Rosa.—J. W. H. Harrison and K. B. Blackburn ("A Preliminary Examination of the Morphology of the Somatic Chromosomes in *Rosa*," *Proc. Univ. Durham Phil. Soc.*, 1931, **8**, 5). Meristematic tissue from the root-tip of the following five species of *Rosa* was studied cytologically: *Rosa lutea* var. *punicea*; *R. gymnocarpa*, *R. pisocarpa*, *R. Soulieana*, *R. spinosissima*. The chromosome complements of the several species were analyzed and figured. Langlet's modification of Navashin's fixative was used, and the material stained with iron-alum hæmatoxylin. *R. lutea* var. *punicea* is found to be diploid and not tetraploid, as recorded by Täckholm and others: the previous classification of the five species is discussed. The five plates figured show that in each species there occurs a pair of chromosomes with satellites, and in *R. spinosissima* possibly two pairs. The remaining chromosomes in each species are compared. The work is considered essentially as preliminary to further investigations. J. L.

Natural Hybridization in Geum.—E. Marsden-Jones ("The Genetics of *Geum intermedium* Willd. (haud. Ehrh.) and its Back-Crosses," *Journ. Genetics*, 1930, **23**, 377–95). Numerous individual plants of *Geum urbanum*, *G. rivale*, and *G. intermedium* are examined from the experimental field at Potterne and when growing wild. Characters of type species, their hybrids and back-crosses are analyzed and compared with specimens collected in the field. The chromosome ratios are recorded and commented upon. The F_1 hybrid *urbanum* × *rivale* is constant, and not intermediate, between the parent species. In characters studied, only three are intermediate, six show *rivale* dominance, in three segregation takes place. Segregation takes place on selfing the F_1. In one case a new hair-characteristic was obtained. Little segregation takes place in selfing the back-cross *intermedium* × *rivale*, a plant closely resumbling *rivale* resulting. Field work in a wood near Bradfield, Berks, shows that this back-cross type predominates, having become stabilized, and tends to replace the parent *rivale*. Thus direct evidence of a new type arising from interspecific hybridization in the field is obtained. J. L.

Meiosis in Œnothera.—J. Adolphina Leliveld ("Cytological Studies in *Œnothera*," *La Cellule*, 1931, **40**, 195–256). An historical survey of the works of Beer, Gates, Geerts, de Vries, Davies, Cleland, Renner and others, upon the cytology of *Œnothera* sp. is given. Evidence for and against telosynapsis is quoted, and the probability of a type approaching parasynapsis suggested. Original observations of pollen mother-cells in *O. Lamarckiana* show 14 chromosomes clearly in 7 pairs in the formation of the synaptic knot. In spite of subsequent thickening, no stage is observed comparable with ordinary pachytene and strepsetene stages: further contraction takes place, and 14 split elements appear for a while: chains of 12 chromosomes appear in diakinesis, with occasional loose pairs: pairing is more pronounced on the equatorial plate, and the chromosomes change shape. Seven chromosomes finally, reach the poles, normally split for the homotypic division. Stages in the reduction division in embryo-sac and pollen mother-cells of several species, and the retardation brought about by cooling, are recorded. All stages are classified and compared with earlier data. In conclusion, meiosis in *Œnothera* is found to fall into three phases, the rapid termination of the first leading to irregularities in the second part as far as metaphase; thus in *Œnothera* neither telosynapsis nor exact parasynapsis is recorded. J. L.

Meiosis and Tetrad-Formation in Rhododendron.—C. G. BOWERS ("The Development of Pollen and Viscin Strands in *Rhododendron catawbiense*," *Bull. Torrey Bot. Club*, 1930, **57**, 285–313). Ripe pollen tetrads in *Rhododendron catawbiense* and four other species are examined under a large number of stains and reagents. Each tetrad is found to have a waxy surface, a common exine of three layers, and an intine slit by six germinal furrows. Viscin strands adhere to the tetrads, forming a network that resists most stains, but reacts to Chamberlain's test for suberin. Immature anthers gathered in August and September show typical meiotic figures nine months before the opening of the flower. The diploid number of chromosomes is 24. All chromosomes are small and have a similar appearance: homologues pair simultaneously in diakinesis, and often show a secondary split that functions in the homotypic division. Two karyokinetic and four cytokinetic spindles are observed during the formation of the spore tetrad. The viscin strands are found to originate from the material of the primary bounding membrane of the archesporial cells, and not from the special mother-cell walls: moreover, they stain at first like the pectin-compound of the middle lamella. Previous literature on pollen formation is reviewed and the results discussed. Figures and microphotographs are appended. J. L.

A Nicotiana Haploid Hybrid.—D. KOSTOFF ("An Androgenic *Nicotiana* Haploid," *Zeitschrift für Zellforschung und mikroskopische Anatomie*, 1929, **9**, 640–2). A cross between an aberrant plant of *Nicotiana tabacum macrophylla* having 70–72 chromosomes and *N. Langsdorffii* ($n = 9$) gave many seeds. Only one F_1 plant reached maturity; this individual resembled the pollen parent (*Langsdorffii*) in every way. Cytological investigation showed that it was a *Langsdorffii* haploid developed in the ovule of an aberrant *N. tabacum*. The case resembles that described by Collins and Kempton (1916) of a cross between *Tripsacum dactyloides* and *Euchlæna mexicana*. No seeds were set after selfing the androgenic haploid tobacco plant, though the back-cross to *Langsdorffii* gave a few. During diakinesis in pollen mother-cells the chromosomes, without true metaphase, pass to the poles at random (2 : 7, 4 : 5) without division. During second maturation all divide, and tetrads, pentads or octads may result. One diploid root-tip was observed, the remaining 57 being haploid. Cell volume ratios are included and photomicrographs inserted in the text. J. L.

Chromatin Mass in Crepis.—M. NAVASHIN ("Chromatin Mass and Cell Volume in Related Species," *Univ. Calif. Pub. Agric. Sci.*, 1931, **6**, 207–30). The present work was carried out to investigate the relationship between normal nuclear mass and cell volume. The volume of cells from the dermatogen of young roots in 13 species of *Crepis* was contrasted with their corresponding nuclear mass. The technique of measurement and calculation is fully explained. In the species investigated the volume of the cell is found to be proportional to the amount of its chromatin. All observations are discussed at length. J. L.

Cytology of Crepis.—C. F. POOLE ("The Interspecific Hybrid *Crepis rubra* × *C. fœtida* and Some of its Derivatives," *Univ. Calif. Pub. Agric. Sci.*, 1931, **6**, 169–200). *Crepis fœtida rhœadifolia*, *C. fœtida typica* and *C. rubra* are described and their somatic garniture investigated. All have five pairs of chromosomes, three pairs being obviously homologous in somatic metaphase plates, while the homology of the other two has been inferred from cytogenetic evidence. After crossing, the characteristics of the F_1 *C. rubra* × *C. fœtida rhœadifolia* are tabulated, also those of the *C. fœtida typica* cross. The F_1 populations were minutely analyzed,

and *fœtida* characters traced in the *rubroid* individuals, though cytologically no *fœtida* chromosome could be recognized. The selfed back-cross to *rubra* is also investigated, and the back-cross to *fœtida*, which proved almost sterile. Crossing-over is indicated. Meiosis in hybrids showing heterozygosis is described. Polyploid forms are discussed: homologous chromosomes from two species, *rubra* and *fœtida typica*, tend to form quadrivalents during meiosis, resulting in irregularities increasing sterility. Pollen viability is discussed. Photographs and text-figures are included. J. L.

Cytology of Crepis Hybrids.—P. Avery ("Cytological Studies of Five Interspecific Hybrids of *Crepis Leontodonoides*," *Univ. Calif. Pub. Agric. Sci.*, 1930, **6**, 135–67). *Crepis Leontodonoides* (haploid chromosome number = 5) was crossed with the following species belonging to three subgenera: *Eucrepis*, species *tectorum* ($n = 4$), *parviflora* ($n = 4$), *capillaris* ($n = 3$); *Barkhausia*, sp. *Marschalli* ($n = 4$); and *Catonia* sp. *aurea* ($n = 5$). The F_1 hybrids possess features of each of the parents. Studied cytologically, the chromosomes of the two parental species can be distinguished in somatic figures in all hybrids, during meiosis in two hybrids, but are indistinguishable in F_1 *Leontodonoides-aurea*. The *Leontodonoides* D-chromosome shows a satellite which disappears in all but the *aurea*-hybrid. The number of bivalents formed at meiosis in different pollen mother-cells differs among the hybrids, but in F_1 *Leontodonoides-aurea* complete pairing occurs. This indicates that the marked morphological similarity of the chromosomes bears some relation to their genetic homology: in other hybrids pairing chromosomes were dissimilar. The evidence for chromosome transformation occurring in *Crepis* spp. is discussed. J. L.

Three Factor Linkage in Primula.—D. de Winton and J. B. S. Haldane ("Linkage in the Tetraploid *Primula sinensis*," *Journ. Genetics*, 1931, **24**, 121–44). Three factors are considered in diploid and tetraploid plants of *Primula sinensis*, and observations taken from work begun in 1909 by R. P. Gregory, together with counts from 2,867 more individuals, to provide data for ascertaining linkage values. An account is given of six types of linkage observed between three pairs of factors in the tetraploid *Primula sinensis*, and of a seventh theoretically possible type. The intensity of linkage varies, and with regard to these factors there is no evidence of crossing-over involving more than two chromosomes at a time, or of two chromosomes going to the same pole after crossing-over. The various results obtained agree well with expectation on the chromosome theory of inheritance. J. L.

Natural Hybridization in Agropyron.—F. H. Peto ("Cytological Studies in the Genus *Agropyron*," *Canadian Journ. Research*, 1930, **3**, 428–48). Eighteen species of the genus *Agropyron* from Western Canada, Russia, Siberia and Denmark formed a polyploid series with a basic number of 7 chromosomes. Di-, tri, tetra- and octaploid forms were found among Western Canadian species; di-, tetra-, penta-, hexa-, and decaploid forms among the Russian and Siberian species; di-, tetra-, and hexaploid forms among the Danish species. Forms collected in Western Canada showed a wide range of morphological variability both within and between the different species. Several morphologically indistinguishable forms showed different chromosome numbers, while many distinct species had the same. In *A. spicatum* constriction and segmentation in certain chromosomes resulted in a higher chromosome number. This variability is considered by the author to be due to natural hybridization, as reported in Russia and Denmark. The

cytology of these European species and their supposed hybrids has been studied and has shown that natural crossing has probably taken place. Some evidence of a similar situation among Western Canadian species has been found. The relation of these phenomena to hybridization is discussed. J. L.

Hybrid Sterility.—E. Anderson and D. de Winton ("The Genetic Analysis of an Unusual Relationship between Self-Sterility and Self-Fertility in *Nicotiana*," *Ann. Missouri Bot. Gard.*, 1931, **18**, 97–116). A single plant of *Nicotiana alata* gave exceptional families when crossed with *N. Langsdorffii*. These were cross-sterile with their self-fertile parent and cross-fertile with their self-sterile parent. On analysis the original *N. alata* is shown to be :—(1) Female-sterile when pollinated with self-fertile *Nicotianas*. (2) Pollen-fertile with a self-fertile *Nicotiana*, giving an F_1 half of which was self-sterile, and as females, cross-sterile with their self-fertile parent. The anomalies are traced in detail, with text-figures, diagrams and photographs. The author interprets them as due to a single factor S_r, belonging to the allelomorphic series S_f, S_1, S_2, S_3, S_4, etc., studied by East. This factor inhibits all pollen carrying the full fertility allelomorph S_f. Attention is called to complications resulting from self-sterility allelomorphs in the inter-species crosses. Possible linkage factors and their crossing-over are discussed. J. L.

Cytogenetics in Cereals.—F. J. Stevenson ("Genetic Characters in Relation to Chromosome Numbers in a Wheat Species Cross," *Journ. Agric. Research*, 1930, **41**, 161–79). This work was carried out to determine, if possible, the relationship between chromosome numbers and genetic characters in a cross between Velvet Don (*Triticum durum*) and Quality (*T. vulgare* Host), and the feasibility of using such crosses in breeding improved varieties of wheat. The cross was made in 1925, and genetic and cytological studies of the F_1, F_2, and F_3 generations were carried out. The characters of both parents were analyzed, and their reactions to stem rust while in the seedling stage experimentally determined. Velvet Don is cytologically a *durum* type with 14 chromosome pairs behaving regularly; Quality is a *vulgare* type with 21 pairs. The F_1 has 14 bivalents and 7 univalents, i.e., 21 chromosomes at metaphase and 35 at anaphase before the division of the univalents; 5 p.c. of F_1 plants set seed. Tables are given for a large number of individual F_1 plants recording their chromosome number and characters and the results analyzed; somatic chromosome numbers of 28, 32 and 42 are recorded. Similarly, tables for F_2 and F_3 plants are given, and the inheritance of different characters traced. Text-figures and photomicrographs are included. The results of the investigation are discussed at length, and are found to contradict the hypothesis put forward by Sax. The author concludes that enough is known to assure the plant breeder that any desired recombination of parental characters in a species cross can be secured if large numbers are used. J. L.

Cytology in Graft Hybrids.—D. Kostoff ("Chromosomal Aberrants and Gene Mutations in *Nicotiana* obtained by Grafting," *Journ. Genetics*, 1930, **22**, 399–418). Irregular meioses were observed in the pollen mother-cells of the scions in certain intergeneric graft unions, namely, *Nicotiana tabacum* on *Datura Wrightii*, *N. Langsdorffii* on *Solanum nigrum*, and *Petunia violacea* on *Solanum nigrum*. Sterile pollen, irregular chromosome behaviour and numbers are described, and the cytology and morphology of the F_1 and F_2 generations investigated. The origin of certain triploid plants through the fusion of a normal egg ($n = 24$) and an unreduced sperm ($2n = 48$), or a diploid egg and normal sperm nucleus, or fusion of abnormal generative nuclei, is recorded. Chromosomal aberrants (monosomic,

trisomic, triploid, hypertriplont, etc.) and gene mutations are recorded and figured from the generations following the selfing of the scion flowers with partly abortive pollen. Control experiments gave normal plants; all results are fully discussed.
J. L.

Chromosome Alterations under X-Rays.—M. NAVASHIN ("A Preliminary Report on Some Chromosome Alterations by X-Rays in *Crepis*," *Amer. Nat.*, 1931, **65**, 243–52). Chromosome variations previously noted are grouped by the author under four headings:—Quantitations, Dislocations, Transformations and Novations, the first being subdivided into Summations (resulting in polyploidy) and Combinations (involving the gain or loss of whole chromosomes). The first and second changes are found to occur spontaneously from 1·0 to 0·1 p.c., though transformations never occur in pure species. To increase the rate of variations, seeds of *Crepis tectorum* were subjected to X-ray exposures ranging from 40–2,200 seconds and planted in garden soil. All germinated, but after six days abnormalities in leaf form developed, being more pronounced among those plants subjected to the larger doses of X-ray. After six months root-tips of abnormal individuals were examined cytologically, and the mutation rate was found to have increased by 600. Only Dislocations were observed among the normal four pairs of chromosomes. The precise changes were traced and figured, and were found to be invariably due to fragmentation and fusion; the size of the fragments varied greatly, though the number of kinetic constrictions remained stable, corresponding to the total chromosome number. Violent chromosome alterations were not found to interfere with normal cellular activity and growth. Large V-shaped chromosomes previously considered to be Novations were now found to be extra large Dislocation. The part played by these chromosome changes in species formation is briefly discussed, and further experiments are outlined for future investigation. J. L.

Influence of Nucleus upon Plasma.—J. A. HONING ("Nucleus and Plasma in the Heredity of the Need for Light for Germination in *Nicotiana* Seeds," *Genetica*, 1930, **12**, 441–68). The influence of increased temperature on percentage germination in the light with 3- and 4-year-old seeds of *Nicotiana* is tabulated. Without light *Deli deformis* plants failed to germinate, or did so in very low percentages under any temperature conditions. The results of alternations in temperature on *Deli deformis* and *Hatano* seeds, and its effect on air-dried and lime-dried seeds, are given. Goodspeed's results are discussed. Taking the need for light as dominant and indifference as recessive, various hybrids were raised and tested. The different results are analyzed and the influence of the seed coat and plasma investigated by back-crosses. Many results are discussed, and the author proposes that "the cause of the need of light for germination and the indifference to it is lying in the nucleus and indirectly in the plasma, while the plasma changes gradually under nuclear influence after hybridization." J. L.

Mitochondria under Radiation.—P. F. MILOVIDOV ("Influence des rayons β and γ du radium sur les chondriosomes de la cellule végétale," *Bull. internat. Acad. Sci. Bohème*, 1929, 12). The influence of radium upon animal or vegetable cells, according to previous writers, is briefly summarized. In the present work young roots of *Pisum sativum* are exposed to the influence of chloride of radium for ½ to 6 hours, and immediately fixed and examined cytologically. Contrary to previous results, the nucleus is found to be more sensitive to radiation than the mitochondria; some figures resembling amitotic division are recorded. Exposure to radiation up to 6 hours leaves some mitochondria still unaltered, while in some cases

chondriosomes are changed in form, but not destroyed. These results are discussed. Owing to the greater absorption of β-rays by the glass and water of the apparatus, their influence upon the tissues is considered to be weak. The γ-rays, being less easily absorbed, have greater influence, and are found to change the nucleus, leaving the chondriosomes practically unaltered. J. L.

Spontaneous Chromosome Alterations.—M. Navashin ("Spontaneous Chromsome Alterations in *Crepis tectorum*," *Univ. Calif. Pub. Agric. Sci.*, 1931, **6**, 201–6). The offspring of abnormal plants of *Crepis tectorum* were grown in 1930 in order that the transmission of chromosome abnormalities might be investigated. A certain percentage of these plants were found to inherit identical trisomics or translocations, while the progenies of three individuals showed, in addition, unusually numerous spontaneous aberrations. Certain progenies were investigated, root-tip material being cytologically examined. Chromosome changes are described, figured, and traced. New types of alterations are recorded, and their origin discussed. The probable influence of somatic dislocations upon the normal course of chromosome conjugation in meiosis is also considered, together with its subsequent genetic significance. J. L.

Chromosome Abormalities.—D. Kostoff ("A Chromosomal Chimera in Tobacco," *Journ. Heredity*, 1930, **21**, 445–8). Abnormal cytology was recorded among the progeny of the back-cross (*Nicotiana glauca* ($n=12$) $\times$ *N. Langsdorffii*) $\times$ *N. Langsdorffii*. One plant showed abnormalities in morphology, cytology, and fertility. Details of character changes are given, with photographs and text-figures. Cytological investigation showed 20, 40, and 26 chromosomes in single root-tips. Chromosome counts were not possible during meiosis owing to the absence of any distinct metaphase. A short discussion on the causes of such somatic doubling and non-disjunction of chromosomes is included. J. L.

Mitosis in Living Cells.—H. Telezyński ("Cycle évolutif du chromosome somatique, observations vitales sur les poils staminaux de *Tradescantia*," *Act. Soc. Bot. Poloniæ*, 1930, **7**, 381–434). The staminal filament of *Tradescantia*, with a small tuft of hairs, was mounted in paraffin oil and observed for 4 or 5 hours while still living. The resting nucleus is described, and chromosome formation in somatic division. Two spirally twisted chromonemata form within each of the chromosomes in the space of a few minutes. Subsequent mitotic phases in their time-relation are photographed, figured, and described. The nuclear appearance of living cells in a large number of plants according to different investigators is discussed at length. J. L.

Chromonemata in Living Cells.—P. Martins ("Étude expérimentale des chromosomes sporocytaires dans le *Tradescantia*," *Bull. Acad. roy. Belg. Cl. des Sci.*, 1929, 5ᵉ série, **15**, no. 3, 160). Meiosis in pollen mother-cells of *Tradescantia* is recorded from observations made on living cells removed from the anther and mounted in isotonic sugar solution. Direct comparison is made, under controlled conditions, of ripe chromosomes in late heterotypic prophase, metaphase, and anaphase fixed with (*a*) Benda's solution, (*b*) Belling's aceto-carmine, (*c*) Bouin's picro-formol. Figures of isolated chromosomes in two planes are included. Similar chromosomes fixed after micro-dissection are studied. In all cases the chromosomes show a dual structure—a non-staining "groundwork," with a deeply staining spirally twisted filament of resistant protoplasm at its periphery—the *chromonema*. To determine whether this dual appearance was provoked by the fixatives, Ringer's solution was used upon the living cell, when chromonemata were observed as before.

When this is replaced by sugar solution, the chromosomes regain their former appearance, and meiosis continues unchecked. Repeated treatment with Ringer's solution is found to have no deleterious effect upon the living cell. Somatic chromosomes in the staminal hairs are unchecked by the solution, but do not reveal chromonemata. Questions of interest arising from these observations are enumerated and discussed. J. L.

An Interpretation of Crossing-Over.—KARL SAX ("Chromosome Structure and the Mechanism of Crossing-Over," *Journ. Arnold Arboretum*, 1930, **11**, 193–221). *Secale* and *Lilium* were studied cytologically and the organization of chromatids found to be unusual. In *Secale seriale* each of the homologous chromosomes at metaphase in the first meiotic division contains a single coiled chromonema. This, during metaphase, contracts and becomes uncoiled, at the same time separating into chromatids. In *Lilium regale* coiled chromonemata are also found at metaphase, but this coiling is not considered essential for the preservation of the linear order of the genes. During meiotic division in both plants and animals the relation of the chromatids is found to be fundamentally the same. In plants the tetrad nature of the bivalent chromosome is not evident till after late metaphase. The reduction in the number of chiasmas between diplotene and late diakinesis is observed, and a cytological interpretation of crossing-over, in accord with genetic requirements, is presented. Figures and explanatory diagrams are appended. The genetic phenomena of interference, gene duplication and deficiency, and variations in crossing-over, are discussed. J. L.

The Species Concept.—E. B. BABCOCK ("Cytogenetics and the Species Concept," *American Naturalist*, 1931, **65**, 5–18). Relative stability, combined with a definite tendency to vary, is generally accepted as characteristic of the "Unit-group" or Linneon. The existence of such Linneons and their perpetuation are ideas on which the formulation of the species concept is founded. The essential ideas of this concept are summarized in seven points. The origin of species and the difficulties of their satisfactory recognition and enumeration are discussed. The linear order of the genes in the chromosome complex is recognized as the basis of Mendelian inheritance. Heritable variation is shown to be due to germinal changes of three main types: genic variation, chromosome transformation, and intraspecific polyploidy. The seven points previously mentioned are amplified, including evidence from cytogenetic research on inter- and intraspecific variation, which adds to the definiteness of the species concept. The value of this concept as enunciated by Vavilov is remarked upon, being in agreement with the present author, namely, "*A Linnæan species is a separate morphophysiological system connected in its genesis with a definite environment and area.*" The value of cytologic and genetic study, together with field observations in all taxonomic research, is strongly emphasized. J. L.

Anatomy.

Coral-like Roots of Cycas and Zamia, and the Alga inhabiting them.—H. CHAUDHURI and A. R. AKHTAR ("The Coral-like Roots of *Cycas revoluta*, *Cycas circinalis*, *Zamia floridana*, and the Alga inhabiting them," *Journ. Ind. Bot. Soc.*, 1931, **10**, 43–59, 4 pls.). The coral-like structures at varying depths below or just above soil level at the bases of plants of *Cycas revoluta*, *C. circinalis*, and *Zamia floridana* are dichotomously branched rootlets. They range in size in the different species enumerated from 2·5 to 3·5 mm., in *Zamia floridana*, to 4 to 6 mm. in *Cycas circinalis*. A green circular layer containing algæ, situated in the middle

of the cortex, can be seen in transverse sections of the roots. The algal layer is interrupted where lenticels are present on the roots, so that the algal zone has the form of a cylinder with gaps in it. The alga present in all species is stated to be *Anabæna cycoideæ*. Bacteria are also present in some of the cells even in roots which do not assume the coral-like development. A detailed account is given, in turn, of the anatomy of the roots of each of the species investigated. The alga is stated to have been isolated from the roots and grown in pure culture in flasks containing a nutrient medium. Flasks containing cultures were buried at different depths in the soil ranging from the surface to 18 inches, and an attempt made to determine at which of these depths the alga grew most actively. In this experiment the alga in the cultures at the surface of the soil showed no development, probably on account of the intense heat. Maximum growth was obtained at a depth of about 6 inches, and at 18 inches there was no growth at all. *Anabæna* was also isolated from the soil up to a depth of 10 inches. A description of *Anabæna* is given. Infection of the roots is thought to take place through the lenticels. The physiological relationship between the alga, bacteria, and the host plant is discussed. C. R. M.

The Root-Tubercles of Podocarpus chinensis.—A. Chaudhuri and A. R. Akhtar ("A Study of the Root-Tubercles of *Podocarpus chinensis*," *Journ. Ind. Bot. Soc.*, 1931, **10**, 2, 92–9, 2 pls.). An account of the anatomy of the roots and root-nodules of *Podocarpus chinensis*. The authors found what they consider to be fungal hyphæ in the cells of the tubercles. It is stated that three fungi were isolated from the tubercles and grown in pure culture. One of these, which remained sterile, is claimed not only to be the cause of the tubercles being formed, but to be capable of fixing nitrogen, which can be utilized by the plants in the roots of which the fungus is present. *Pseudomonas radicola* was not observed in the tubercles. C. R. M.

Growth in Thickness of Gymnosperms and Woody Dicotyledons.—C. Carstens ("Das Dickenwachstum der Gymnospermen und holzigen Dikotyledonen," *Beiheft z. bot. Centralb.*, 1931, **48**, 1 & 2, 97–117, 13 figs.). The growth in thickness of woody stems of dicotyledons was first investigated by Sachs, de Bary, and Schenck during the last century. These authors considered that the cambium is first laid down in the vascular bundles, but that later on, following periclinal divisions, it extended between the bundles to form an interfascicular cambium. This series of events, which was noted especially in *Ricinus*, was considered to be typical for dicotyledons in general, and later on, when other methods of growth in thickness were discovered, they were regarded as atypical. This view was maintained until 1924, when Kostytschew reinvestigated the problem. In the present paper an extension of Kostytschew's work is described, and the conclusions reached agree very closely with those obtained by that author. Kostytschew, who worked chiefly with herbaceous stems, found three different types of development in different plants. The most frequent type is that in which a closed procambium ring is laid down, by the activity of which continuous rings of xylem and phloem are produced. The author has found this type occurring with only minor variations, not only amongst the Taxaceæ, Cupressaceæ, and Abietaceæ, in the Gymnosperms, but in 38 families of dicotyledons. The second type described by Kostytschew is commonly known as the *Aristolochia* type. In this type a closed procambium ring is first laid down. In this leaf-trace bundles at once arise. In the leaf-traces the cambium gives rise to xylem and phloem, but the cells between the leaf-trace bundles assume the characters of parenchyma, and

can be distinguished from the parenchyma cells of the primary cortex only by their smaller size. At a later stage, when the leaf-traces are more numerous, an interfascicular cambium gives rise to parenchyma cells only on the inside. These subsequently become elongated and lignified. The author regards this mode of development as a variation of the normal type already described. It has been seen in the following families :—Piperaceæ, Nyctaginaceæ, Ranunculaceæ, Menispermaceæ, Papilionaceæ, and Anacardiaceæ. Kostytschew also recognized a third type of development in which the procambium ring gives rise to groups of mechanical and conducting tissue. In the leaf-traces the cambium produces conducting tissue on the inside and phloem on the outside, whilst between the leaf-traces it gives rise only to wood fibres. This type, which is known as the Umbellifer type, is not further dealt with by the present author. There is a discussion of the theoretical significance of the results obtained. C. R. M.

Stem Structure of Crassula spp.—K. E. Mass ("Die Entwicklung des Stammaufbaues einiger Crassula-arten," *Beiheft z. bot. Centralb.*, 1931, **48**, 1 & 2, 118–53, 1 pl., 11 figs.). An account of the development of the stem structure of the following species of *Crassula* :—*C. tetragona* Linn., *C. trachysantha* Haw., *C. monticola* N.E.Br., *C. perfossa* Linn., *C. lycopodioides* Lam., *C. imbricata* Burm. The investigation was made by examining microtome and freehand sections of the non-flowering stems of these species cut through the apical growing point, and at different distances behind it. The details of development in each of the species examined are described in turn. It was found that the development proceeded along much the same lines in all the species examined, except *C. monticola* and *C. perfossa*, which differed from the others in several respects, as will be seen below. Generally speaking, the growing point was circular (except in *C. perfossa*, in which it was more or less elliptical), and the leaves arose behind the growing point regularly in opposite pairs. *C. perfossa* also differed in having leaves that were arranged asymmetrically to begin with, but later on this irregularity disappeared. In all the species examined, the entire vascular system at the upper end of the stem served as leaf-traces. In *C. tetragona*, *trachysantha*, *lycopodioides*, and *imbricata* there was one leaf-trace to each leaf, but in *C. monticola* and *C. perfossa*, which have broad leaves, there were three. The xylem is formed centrifugally. In all the species, with the exception of *C. perfossa* and *monticola*, the xylem at first consists of four groups in a ring, an arrangement which is clearly correlated with the phyllotaxy. In *C. monticola* and *perfossa*, in which there are three traces to each leaf, the xylem is first laid down in 12 groups in a ring. In these two species the pith cells become lignified. The cortex and epidermis develop in the same way in all the species. The epidermis is at first thin-walled, and the homogeneous cortex composed of parenchyma cells. Later on, the cells of the hypodermal layer become collenchymatous, and the epidermis is strengthened. Subsequently cork is formed. In *C. tetragona* and *trachysantha* the cork is formed in the hypodermal region, whilst in *C. monticola* and *perfossa* it arises in the cortex. Very little cork is formed in *C. lycopodioides* and *imbricata*, in which the stem is more or less covered with imbricate leaves. The pith is well provided with intercellular spaces. In *C. monticola* and *perfossa*, when the pith cells become lignified (but not pitted), the intercellular spaces disappear. The xylem consists of spirally thickened elements (reticulate thickening also occurs in young stages). In the secondary xylem there are scattered groups of unlignified parenchyma cells arranged in approximately concentric rings. There is an endodermis in all the species, but this does not persist after the woody cylinder has been formed. The paper ends with a full discussion of the results obtained. C. R. M.

Stem-Endodermis of Piper.—G. Bond ("The Stem-Endodermis of the Genus *Piper*," *Trans. Roy. Soc., Edin.*, **56**, 695–724, 3 pls., 11 figs.). A great deal has been done by previous workers on the peculiarities of the vascular anatomy of the stems of *Piper* spp. However, the existence of a stem-endodermis in the genus appears to have commanded little attention. The structure of the endodermis has accordingly been fully investigated in eight species of the genus. Microtome sections of the younger internodes were chiefly used, but were supplemented by free-hand sections, especially of the older internodes. The best stain for differentiating the caspary strip was basic fuchsin. Sections were cleared with Eau-de-Javelle before staining. Ribbons were attached to the slides by a collodion—clove oil fixative. An outline of the arrangement and development of the vascular bundles is given. No endodermis is associated with the medullary vascular bundles. Of the species examined, only one (*P. celtidifolium*) was devoid of an endodermis associated with the outer ring of bundles. In *P. angustifolium*, *P. porphyrophyllum*, and *P. nigrum* the endodermis was uniformly distributed when fully matured, but the caspary strips were first laid down so as to form caps over the phloem groups of the outer ring of vascular bundles. Later on, the caspary strips extended across the primary medullary rays, thus forming a continuous cylinder. In *P. excelsum* considerable variation in the extent to which the caspary strip develops was found to occur. In some instances an almost complete cylinder was present, whilst in others the caspary strip was confined to forming "caps" over the phloem groups. The extent to which the caspary strip is developed varies not only in different shoots on one plant, but also in different internodes in one shoot. In *P. chaba*, *P. tiliæfolium*, and *P. decurrens* there was a considerable variation in the extent to which the caspary strip developed even within individual shoots. The nature of the caspary strip in the internodes of *P. porphyrophyllum* and *P. excelsum* was also examined. In the first of these two species there was very little interruption of the strip at the internodes, except where vascular strands passed into the cortex and so to the leaf bases or axillary buds. There was also some evidence that the deposition of the caspary strip was somewhat delayed at the base of each internode. There was no caspary strip associated with the bundles where they passed through the cortex. The endodermis of *P. excelsum* was partially discontinuous at the fourth internode, the degree of discontinuity increasing on passing from above downwards through the internode. The earliest stages of caspary strip development were noted at a few millimetres behind the apical bud in *P. porphyrophyllum* and *P. angustifolium*, an arrangement which is true of most species. In *P. excelsum*, however, strip formation was first encountered in the second internode. The caspary strip is exceptionally large when it has reached its full size, transverse sections showing the radial length to be as much as 5·7μ in *P. excelsum*. In *P. angustifolium* slight undulation of the radial and transverse walls was observed, but this undulation is uncommon in the genus. The swollen appearance of the caspary strip as seen in transverse section is due to the fact that here the strip is definitely a thickened part of the radial wall. Pits are present on the radial walls of the endodermis, especially in *P. angustifolium*, and indentations are formed around these in the caspary strip as the latter is laid down. The endodermis is capable of becoming accommodated to increases in thickness of the stem chiefly by the elongation of individual cells in a tangential direction, and to a lesser extent by "the disappearance or diminution of the undulations which characterize the endodermis in young internodes." Considerable irregularities in the way in which the caspary strip was laid down in the endodermal cells were noted in certain species of *Piper*, especially in *P. angustifolium*. Secretory cells were noted actually in the endodermal layer as well as in other parts of the

stem. Sometimes a complete interfascicular cambial layer is formed by some of the endodermal cells acting as cambium mother-cells and dividing tangentially. The results obtained in the investigation are fully discussed, and comparisons are drawn between the results and conclusions of Priestley on the position, origin, and function of the endodermis and those obtained by the present author.

C. R. M.

So-called "bois périphérique" of the Umbelliferæ and the Misuse of Terms in Plant Anatomy.—S. Buchet ("Sur le prétendu 'bois périphérique' des Ombellifères et sur l'abus des termes impropres en anatomie végétale," *Bull. Soc. Bot. de France*, **77**, 697–9). The author objects to the use of the term "bois périphérique" otherwise than to denote the wood secondarily formed around the phloem of the vascular bundles of Monocotyledons. It should not be regarded as synonymous with "bois concentrique." He also draws attention to examples of misuse of certain other anatomical terms. C. R. M.

Different Types of "bois périphérique."—R. Lemerle ("Des différents modes de bois périphérique," *Bull. Soc. Bot. de France*, **77**, 9 & 10, 700–1, 1 fig.). A reply to the note of Buchet (*see* last abstract). The author considers that the term "bois périphérique" should be used to denote all wood more or less surrounding the phloem. C. R. M.

Anatomy of Climbing Plants.—R. H. Dastur and G. A. Kapadia ("The Anatomy of Climbing Plants," *Journ. Ind. Bot. Soc.*, 1931, **10**, 2, 110–21, 2 pls.). An account of the anatomy of a number of climbing plants which occur in the Bombay Presidency belonging to the families Menispermaceæ, Capparidaceæ, Malpighiaceæ, Vitaceæ, Sapindaceæ, Leguminosæ, Oleaceæ, Apocynaceæ, Asclepiadaceæ, Convolvulaceæ, Aristolochiaceæ, Piperaceæ, Euphorbiaceæ, and Liliaceæ. The anatomical characters of the climbing stems of each of the species examined are described in turn, so that the paper has the form of a catalogue of anatomical peculiarities. The plants examined appeared to be characterized by an unequal development of the secondary xylem, so that it was star-shaped in outline as seen in transverse sections. In other cases the secondary xylem was broken up into small groups. The wood and mechanical tissue developed more vigorously on that side of the stem which was in contact with the support than on the other.

C. R. M.

Anatomy of Root and Rootstock of Eriocaulon septangulare.—R. Solomon ("The Anatomy of the Caudex and Root of *Eriocaulon septangulare*," *Journ. Ind. Bot. Soc.*, 1931, **10**, 2, 139–44, 2 pls.). Members of the genus *Eriocaulon* are herbs growing in swampy places in tropical or sub-tropical regions. In habit they resemble *Isöetes*, but bear flowers which are stated to show affinities with the Compositæ. The caudex or rootstock is 1 to 4 inches long. Its most remarkable anatomical peculiarity is the cortex, which consists of bladder-like cells with outwardly directed projections. There are abundant intercellular spaces in the cortex of the root, which are interrupted at intervals by horizontal diaphragms.

C. R. M.

Water-Storage in the Leaves of Some Indian Halophytes.—D. P. Mullan ("Observations on the Water-Storing Devices in the Leaves of Some Indian Halophytes," *Journ. Ind. Bot. Soc.*, 1931, **10**, 2, 126–33, 3 pls.) In a study of the anatomy of the leaves of a number of plants growing in mangrove swamps, it was found that the leaves were usually provided with enlarged hypodermal cells (in

some plants cells which were more deeply seated were enlarged), which served for the storage of water. In "psammophilous halophytes," on the other hand, the epidermal cells were large in proportion to the thickness of the leaves, and were thought to carry out a similar function. Inland forms of some of the plants growing in these two types of habitat were studied, and in them the water-storage cells were not so large as in the halophytic forms. The size of the water-storage cells is stated to be proportional to the quantity of salt in the soil. In wet weather the leaves of psammophilous halophytes take up an excess of water, which is stated to be of use to the plant in time of drought. In *Clerodendron inerme* Gaertn. and *Launæa pinnatifida* Cass. water is stored in the leaves, chiefly in the greatly enlarged mesophyll cells in which the chlorophyll becomes decomposed.

C. R. M.

Distribution of Saponin in Jagera pseudorhus.—W. D. Francis ("The Location of Saponin in the Foam-bark Tree (*Jagera pseudorhus*)," *Proc. Roy. Soc., Queensland*, **40**, 5, 51–60, 2 pls.). *Jagera pseudorhus* was used in Australia during the War as a source of saponin in the place of Quillaja bark. The paper gives an account of the distribution of saponin in the different tissues of this plant. Saponin was detected by (1) the formation of a froth (easily dispersed by alcohol) when tissues containing saponin were shaken in distilled water; (2) the production of a reddish-violet colour when sections were treated with concentrated sulphuric acid and absolute alcohol; (3) the insolubility in absolute alcohol and the solubility in water of most saponins. By the application of these tests, saponin was detected in the stem, branchlets, and secondary roots, where it appeared to be most concentrated in the cell walls. Although it was present in some of the cortical cells of the stem, branchlets, and secondary roots, it occurred chiefly in association with lignified tissues or those which were about to become lignified. It was especially noted in the sclerenchyma sheath of the stem, branchlets, and secondary roots; in the fibres in the outer part of the phloem of the stem, branchlets, and secondary roots; in the xylem of the young twigs; in the sclerenchyma groups and spiral vessels in the wall of the fruit. Scarcely any saponin was detected in tissues containing chlorophyll. It is conjectured that saponin may be of importance in forming the cell walls of lignified tissues.

C. R. M.

Influence of Variations in the Habitat Conditions and Treatment with Hydrocyanic Acid Gas on the Anatomical Structure of Certain Liliaceæ.—W. Goette ("Untersuchungen über die Beeinflussung des anatomischen Baues einiger Liliaceen durch Standortsfaktoren und experimentelle Eingriffe (Blausaure-Begasung)," *Beit. zur Biol. der Pflanzen*, **19**, 1, 35–65). An account is given of the anatomical structure of *Convallaria majalis* grown in seven different types of habitat; *Aspidistra elatior* leaves exposed to strong and subdued light respectively; lowland and mountain forms of *Majanthemum bifolium*. Comparisons are also drawn between the structure of some *Convallaria majalis* plants treated with hydrocyanic acid gas and that of some that were not. It was found that the individual tissues from various parts of one single-leaf-lamina of *Convallaria majalis* differed from one another considerably. The chief variations were noted in the size of the epidermal cells, and in the size of the stomata and their number per unit area. In making comparisons between the anatomical features of leaves from plants grown in different habitats, it is, therefore, important to draw conclusions only from a study of the tissues from the corresponding parts of the leaves to be compared. The principal variations noted in *Convallaria majalis* were that (1) The number of vascular bundles in the roots and rhizomes varies according

to the total mass of the tissues composing these organs; (2) the length and breadth of the epidermal cells on both surfaces of the leaf varied, as did also the size and frequency of the stomata. There were also variations in the upper assimilating cells. No direct correlation was established between any one variation in anatomical structure and any individual habitat factor. The length and breadth of the epidermal cells of the leaves of *Convallaria majalis* increased and the number of stomata decreased after treatment with hydrocyanic acid gas. The extent of the deviation from the normal untreated control plants depended on the intensity of the treatment. Sun and shade leaves of *Aspidistra elatior* showed the following variations :—In sun leaves the epidermal cells on both surfaces were a little longer and broader, and the stomata more numerous than in shade leaves. The size of the stomata was the same in both types of leaf. The assimilating cells on the underside of sun leaves were shorter but broader. Lowland and mountain plants of *Majanthemum bifolium* showed great variations in the number and size of the stomata. C. R. M.

Abscission Tissue in Ricinus.—H. SIGMOND ("Das Trennungsgewebe der männlichen Ricinusblüte. Untersuchungen über Trennungsgewebe I," *Beih. Bot. Centralbl.*, 1931, **48**, 155–65, 3 figs.) The male flowers of *Ricinus communis* L. possess five connate perianth-segments. At the regions of union the tissue is constricted, so that the individual segments remain distinct. This tissue, which unites the perianth-segments to each other, consists of small rounded (isodiametric) cells. The opening of the flower-bud depends on an abscission taking place in the small-celled tissue, which is therefore known as "abscission tissue." During and directly after the opening of the flower the cells of the abscission tissue are alive and turgid, but later they die and shrivel up. The process of flowering depends on an increase of turgor in the abscission tissue, followed by rupture, without dissolution, of the middle lamellæ of the cell walls. This abscission is thus not a pure cleavage (schizolysis), but also a disruption (rhexolysis). The abscission tissue thus functions primarily as a connecting tissue uniting the sepals, and later it changes its function to become an agent in the unfolding of the perianth.

A. W. E.

Nutritive Layer of Pollen in the Angiosperms.—M. MASCRÉ and R. THOMAS ("Le tapis staminal (assise nourricière du pollen) chez les Angiosperms," *Bull. Soc. Bot. de France*, **77**, 654–64, 6 figs.). An account of the development of the layer of nutritive cells adjoining the pollen mother-cells in the stamens. Two types of nutritional layer occur in different plants. In one of these the nutrient cells persist until the pollen grains are mature, whereas in the other the cells fuse together in the cavities of the mature anthers and form a plasmodium in which the pollen grains are situated. The development of both these types proceeds in the same way until the young pollen grains become separated from one another, when in the one case the cells break down and form a plasmodium, whereas in the other they do not. The cells constituting the nutritive layer towards the outside of the anthers arise from the cells of the hypodermis by a series of tangential divisions, whereas the nutritive cells on the inside arise from the ordinary cells of the connective. The nutritive cells are at first uninucleate, but later on, following typical divisions, they become either two or four nucleate. Still later on the nuclei fuse, so that the cells become uninucleate for a second time. The mature cells contain a large vacuole at either end, whilst the nucleus remains in a bridge of cytoplasm at the centre. Small plastids, mitochondria, and fatty materials are also present in the mature cells. As soon as the pollen grains begin to separate,

the nuclei and cytoplasm undergo degeneration. The cell membranes undergo modifications analogous to cutinization, becoming thickened and provided with perforations. When the pollen grains separate, the nutritive cells secrete the staminal fluid at the same time as they are decomposing. The composition of the fluid is uncertain, but it has the power of reducing Fehling's solution.

C. R. M.

The Origin of the Six Germinal Furrows in Dahlia Pollen Grains.—R. P. WODEHOUSE ("The Origin of the Six Furrowed Configuration of *Dahlia* Pollen Grains," *Bull. Torrey Bot. Club*, **57**, 6, 371–80, 1 pl.). The pollen of *Dahlia* spp. differs from that of other Compositæ (and most dicotyledons) in having six germinal furrows instead of the customary three. A second interesting difference is that whereas in most Compositæ the four nuclei of the homotypic division are arranged in the form of a tetrahedron, in *Dahlia* spp. they lie in one plane in a square or rhomboidal arrangement. There are four spindles connecting the nuclei instead of the usual six. Furrows are formed which constrict across the spindles connecting the four nuclei. It thus happens that the daughter-cells come in contact with one another only at two points instead of the usual three. These two points determine the position of the six symmetrically placed furrows.

C. R. M.

Development of the Endosperm of Maize.—L. LAMPE ("A Microchemical and Morphological Study of the Developing Endosperm of Maize," *Bot. Gaz.*, **91**, 337–76, 1 pl., 7 figs.). In this paper an account is given of the changes which take place in the developing endosperm of maize grains as revealed by microchemical methods. The four types of maize known as starchy, waxy, sweet, and waxy-sweet were studied. The development of individual cells in the endosperm is first described, followed by that of the endosperm as a whole. The first change noted in a cell destined to serve for the storage of polysaccharides was that the cell itself, as well as its vacuole and nucleus, became enlarged. Granules were present in the cytoplasm, in association with which the polysaccharides were formed, at first scattered, but later becoming aggregated around the nucleus. As the plastids were formed, the cell vacuoles and the sap they contained gradually disappeared. The plastids increased in size for 30 days after pollination. In studying the distribution of polysaccharides in the endosperm as a whole during its development, it was found that there was a gradient from the summit of the grain, in which polysaccharides were first deposited, to the base of the grain, where they were not deposited until later on. Cells in between these two points showed a succession of stages in the formation of polysaccharides. It was found that the nature of the polysaccharides present in the mature grain depended upon the hereditary origin of the different varieties of maize. In non-sweet maize large simple grains of carbohydrate were produced, whereas in sweet maize large compound grains were present accompanied by liquid dextrin. The formation of waxy and non-waxy starch also depended upon the inherited characters of the grain. The nature of the carbohydrate deposit in individual cells also varied according to their position in the endosperm tissue. As the cells matured, the amount of reducing sugar present in them decreased, whereas the sucrose content reached a maximum 15 days after pollination and then decreased. The total sugar present in the endosperm 15 days after pollination was greater in sweet than in pseudo-starchy and non-sweet varieties. From mature endosperms of non-sweet varieties sugars were completely absent, whereas in sweet and pseudo-starchy varieties a small quantity of sugar persisted. Whilst the grain ripened, the cells

lost their remaining sap. This process proceeded from the apex of the grain to the base, starting 35 to 40 days after pollination. The moisture content of the grain decreased progressively while these changes were going on, and was accompanied by an increase in dry weight which corresponded to the quantity of polysaccharide that was synthesized. C. R. M.

Morphology.

Layering Habit in Sitka Spruce and the Two Western Hemlocks.—W. S. Cooper ("The Layering Habit in Sitka Spruce and the Two Western Hemlocks," *Bot. Gaz.*, **91**, 441–51, 4 figs.). It is characteristic of certain coniferous trees, especially in the genera *Abies* and *Picea*, to develop horizontal branches a short distance above ground level. These subsequently bend round and assume an upright position. Later on, the horizontal portions of the stems become covered with plant debris, beneath which they give rise to adventitious roots, and eventually a number of young trees is thus formed. This habit is especially well seen in *Picea sitchensis* Carr., *Tsuga Mertensiana* Carr., and *Tsuga heterophylla* Sarg. The shape of the layering branches is unusual, since their diameter is relatively small where they leave the parent tree, but it increases to within a short distance of the upward bend. In this paper an account is given of the microscopical appearance of two small layering branches of *Picea sitchensis* and one of *Tsuga Mertensiana*. It was found that one particular branch of *Picea sitchensis* grew to be 65 cm. long in the first five years of its life. During the next eight years it became only 43 cm. longer. After the thirteenth year, growth near the trunk ceased, but new rings were added nearer the apex of the branch. The greater diameter of the branch away from the parent trunk than at the point where it left it was associated with the development of adventitious roots. The branch tip turned upwards about the eighth year. The wood developed in asymmetric rings in the horizontal part of the branch. This started between the eighth and thirteenth years, when more wood was added on the lower than on the upper side of the branch. In the twenty-eighth year the asymmetrical growth ceased, and very little wood was produced, especially on the upper side of the branch, where its formation practically came to an end. In the branch of *Tsuga Mertensiana* examined, five and ten annual rings were observed at two points within the parent trunk, at the surface of the trunk there were 33, and just before the bend 44. The horizontal portion was 75 cm. long, and bore scattered roots at a point 30 cm. from the trunk towards the bend. The vertical portion was 45 cm. tall. An attempt is made to explain the peculiar habit of the layering branches on a physiological basis. C. R. M.

Phylogenetic Evolution of the Phyllome.—K. Domin ("Phylogenetic Evolution of the Phyllome," *Amer. Journ. Bot.*, **18**, 237–42). A restatement of the author's views on the phylogenetic evolution of the phyllome. According to his view, the phyllome originally consisted of a one-membered body which became differentiated (phylogenetically) into a sheathing base and an expanded distal portion concerned primarily with assimilation. The auricles of the sheath lengthen, and the sheathing base is shortened, so that eventually the auricles become entirely free from the base of the sheath and persist as free stipules. In later stages of their evolution the stipules of the dicotyledons have assumed many diverse forms, such as spines, tendrils, etc. The author states that ontogenetic work does not always fully support his theory, but thinks this is of little importance. C. R. M.

Phylogeny and Ontogeny of the Cataphyll.—A. S. Foster ("Phylogenetic and Ontogenetic Interpretations of the Cataphyll," *Amer. Journ. Bot.*, **18**, 243–9). The author regrets that in many instances cataphylls are

referred to as " reduced " foliage leaves, since this suggestion does not account for the striking differences observed between cataphylls and foliage leaves. Furthermore, he states that there is at present no "satisfactory morphological or causal interpretation of the cataphyll." In opposition to Domin (*see* last abstract), the author lays great stress on the importance of ontogenetic studies of cataphyll development. The early part of the paper is concerned with the critical detailed examination of certain of Domin's statements. The author's attitude is that since the " scale habit " has existed in a great diversity of plants from archaic types such as *Ginkgo biloba*, and is shown in a great variety of forms at the present day, and as, moreover, all phylogenetic systems are at present being examined and revised, it is inadvisable to assume that the cataphylls in all plants have developed phylogenetically along the same lines. Goebel considered that cataphylls arise from primordia in every way comparable to foliage leaf primordia, but that after an " arrest " in their segmentation they pursue an independent ontogeny. This theory was based chiefly on defoliation experiments, in which it was claimed that primordia, which from their position on the axis should have given rise to cataphylls, were induced experimentally to become foliage leaves. Recent work by Schuepp on *Acer Pseudoplatanus* has failed to confirm this conclusion, as has also work by Diels on *Asarum europæum*. The author considers that at the present time the most important lines of investigation on the origin of the cataphyll are: (1) *Complete* ontogenetic studies of the development of the cataphyll. (2) A study of the internal differentiation of the scale, with special reference to the position in it of meristematic tissue. (3) Studies of development such as those carried out by Blaauw, who has shown that in *Aesculus Hippocastanum* there are definite scale- and foliage-leaf forming periods. Moreover, the bud scales have been shown to be laid down at a faster rate than foliage leaves. C. R. M.

Formation and Development of Roots and Shoots on the Isolated Cotyledons of Cucurbita, Cucumis, and Lupinus.—M. C. Fuja (" On the Formation and Development of Roots and Shoots in the Isolated Cotyledons of *Cucurbita, Cucumis* and *Lupinus*," *Bull. Acad. Polon. Sci. et Lettres, sér.* B, *Sci. Nat.* (1), 1929, 209–18, 4 pls.). The author finds that if cotyledons of various ages are removed from seedlings of *Cucurbita, Cucumis*, and *Lupinus* spp. and grown on moist blotting-paper under bell-jars, they may give rise to roots or young plants. If the cotyledons of *Cucurbita Pepo, Cucumis sativus* and *Lupinus* spp. are removed from the seedlings without damaging the buds in their axils, shoots develop from the axillary buds. In some instances entire plants were raised in this way. The isolated cotyledons of *Cucurbita, Cucumis* and *Lupinus* developed calluses where the nerves were cut, and from these roots were developed. In rare cases shoots also developed. In some lots of seedlings of *Lupinus albus* the roots arose from the cut ends of the veins without a callus being formed. Cotyledons isolated from embryos or young seedlings produced roots more actively than did those from older seedlings. C. R. M.

Germination of Seed and Development of Seedling in Dionæa muscipula.—Cornelia M. Smith ("Development of *Dionæa muscipula*. II. Germination of Seed and Development of Seedling to Maturity," *Bot. Gaz.*, 1931, **91**, 377–94, 36 figs.). In germination of the seed and development of the seedling of *Dionæa* the hypocotyl and the primary root elongate, rupture the nucellar cap, and push aside the seed lid; the cotyledons partially emerge, turn green, and straighten up, carrying the seed with them. One cotyledon releases itself completely and the other remains attached by its tip end, the two then diverging and

young leaves appearing between them. The stem apex, which gives rise to leaves in spiral succession, gradually moves horizontally from between the cotyledons, forming a subterranean rhizome, from the lower surface of which adventive roots arise; the cotyledons, hypocotyl, and primary root finally cease to function and are sloughed off the basal end of the rhizome of the now independent plant. The hypocotyl and the primary root are similar in structure, both having epidermis, cortex, endodermis, pericycle, and a diarch stele; there is no transition region in the hypocotyl, the vascular bundles being inverted where they enter the cotyledons; the cotyledons, with stomata and stellate hairs present on both upper and lower surfaces, have a median collateral endarch vascular bundle from which two or more lateral branches extend. The rhizome appears to consist of an agglomeration of overlapping undiverged leaf-bases. The root hairs, which begin to form a few millimetres behind the growing point, soon turn brown and become thick-walled, often persisting throughout the life of the root. They appear to be vestigial structures. The evidence gained from a comparative study of the development of *Dionæa* and its allies indicates that *Dionæa* should be placed in the family Droseraceæ and in the order Sarraceniales. A. W. E.

Floral Morphology of Lyonothamnus floribundus.—J. B. JULIANO ("Floral Morphology of *Lyonothamnus floribundus*," *Bot. Gaz.*, 1931, **91**, 426–40, 29 figs.). *Lyonothamnus floribundus* Gray, a flowering tree endemic to the Channel Islands off the coast of California, has been placed by various systematists in the Rosaceæ, Saxifragaceæ and Cunoniaceæ. In its floral morphology it possesses both saxifragaceous and rosaceous features. Development of the carpels before all the stamens are formed agrees with some of the Rosaceæ and a few of the Saxifragaceæ; the one-celled archesporium, the failure to form a *coiffe épidermique*, the absence of an obturator, and the development of a cellular basal apparatus, are features purely saxifragaceous in nature; and the differentiation of many nucellar cells exhibiting characters typical of spore mother-cells indicates a close relationship with the Rosaceæ. The peculiar elongation of the megagametophyte prior to fertilization, and its seed characters (simple modification of the integument, large embryo with a pair of fleshy plano-convex straight cotyledons, unenlarged basal suspensor cell and sparingly developed endosperm) are also features found among the Rosaceæ. The formation of two series of ovules in the ovary, a morphological criterion by which Engler and Prantl separate the Cunoniaceæ from the Saxifragaceæ, shows that *Lyonothamnus* is a genus possessing heterogeneous morphological characters which tend to obliterate the distinction between the Rosaceæ and Saxifragaceæ and at the same time a cunoniaceous arrangement of ovules. It should perhaps be regarded as a transitional form between Saxifragaceæ and Rosaceæ on the one hand and Cunoniaceæ on the other. A. W. E.

Morphology of Pollen Grains.—T. C. N. SINGH ("Studies in the Morphology of the Pollen Grain. I (a). Boraginaceæ," *Journ. Ind. Bot. Soc.*, 1931, **10**, 38–42, 1 pl.). A morphological description of the pollen grains of the following species of Boraginaceæ:—*Nonnea pulla* Lamk., *Anchusa italica* Ritz., *Gastrocotyle hispida* Bunge, *Borago officinalis* L., *Heliotropium supinum* L., *Heliotropium marifolium* Ritz., and *Myosotis cæspitosa* Schultz. The author entirely disagrees with the conclusions of Pope (*Bot. Gaz.*, **80**, 66) that the Boraginaceæ as a group are characterized by small dumb-bell-shaped pollen grains. Of the species examined, only *Myosotis cæspitosa* conforms to this type. Pollen grains of more than one size were found in individual anthers of all the species examined, with the exception of *Myosotis cæspitosa*. C. R. M.

Bicarpellary Pistils in Saraca indica.—C. S. KRISHNAMURTI ("A Note on the Occurrence of Bicarpellary Pistils of *Saraca indica*," *Journ. Ind. Bot. Soc.*, 1931, **10**, 2, 159, 1 pl.). A note on the occurrence of flowers of *Saraca indica* with two carpels. These were found growing in the Botanic Garden at St. John's College, Agra. C. R. M.

The Monocotyledons are Monocotylous,—W. WINKLER ("Die Monokotylen sind monokotyl," *Beitr. z. Biol. der Pflanzen*, **19**, 1, 29–34). A discussion of the various theories which have been put forward concerning the relationship of the Monocotyledons to the Dicotyledons. The main question discussed is what has become of the second cotyledon in monocotyledonous seedlings. The well-known theories of Arber, Sargent, Hill, Lotsy, Wettstein, etc., on this subject are briefly reviewed. The author considers that Monocotyledons are indeed characterized by the possession of a single cotyledon, and that this organ cannot be regarded as two cotyledons fused together. C. R. M.

Notes on Indian Plant Teratology.—T. S. SABNIS ("Notes on Indian Plant Teratology," *Journ. Ind. Bot. Soc.*, 1931, **10**, 1, 21–6, 3 pls.). A description of abnormal forking in the axes of *Saccharum officinarum* L., in the leaves of *Anacardium occidentale* L., in the cotyledons of *Michelia champaca* L., and the cobs of *Pennisetum typhoideum* Rich. It is thought that forking may represent a "reversion," or be the result of a single growth centre being replaced by two or more. A case of axillary proliferation in *Brassica oleracea* L. var. *caulorapa*, which developed in plants raised from seed imported to India from Europe, is attributed to change of climate and edaphic factors. Examples of fasciation were noted in *Linum usitatissimum* L., garden roses, daisies, *Eutoca viscida* Benth., and *Cucurbita maxima* Duchesne. The author states reasons for considering fasciations to be genetic in origin. The references in the text to figures in the plates are not all correctly numbered. C. R. M.

Teratology of Indian Plants, VI.—T. C. N. SINGH ("On the Teratology of Certain Indian Plants," *tom. cit.*, 134–8, 1 pl.). This paper consists of notes on the following abnormalities observed in the plants mentioned:—(1) The occurrence of three cotyledons in *Ricinus communis*, *Carica Papaya* and *Zinnia elegans*. (2) Double leaves in *Ficus religiosa* and *Zinnia elegans*. (3) Double nuts in *Areca Catechu*. (4) Fasciated stems in *Ipomœa pulchella* and peduncles of *Jasminum sambac*. (5) Small cone-like bodies on the rachis and shoots of *Acacia arabica*. C. R. M.

Teratology of Indian Plants, VII.—B. N. SINHA ("Notes on the Teratology of Certain Indian Plants," *tom. cit.*, 160–4, 1 pl.). A brief description of syncarpous specimens of *Musa paradisiaca* var. *sapientum* L., *Mangifera indica* L., *Punica Granatum* L., *Diospyros Kaki* L., and *Solanum Melongena* L. C. R. M.

CRYPTOGAMS.

Pteridophyta.

Gametophytes of Equisetum.—ELDA R. WALKER ("The Gametophytes of Three Species of *Equisetum*," *Bot. Gaz.*, 1931, **92**, 1–22, 54 figs.) From a study of the gametophytes of *Equisetum kansanum*, *E. Telmateia* and *E. arvense* in the field and in cultures on sphagnum, it is found that all three agree in having a massive base, a meristematic rim, and upright green branches, but differ much in the character of these branches. Archegonia and antheridia are borne on the massive

tissue; rarely antheridia occur on upright branches. Normal thalli are monœcious; starved plants are male. Archegonia arise from meristem that is forming upright green branches and many rhizoids. Antheridia develop from meristem that is forming reduced branches and few rhizoids, and at maturity occupy regions void of chlorophyll. After developing antheridia, the thallus rests for a time. Normally, archegonia are produced first, then antheridia; later on, more archegonia may be developed, followed by antheridia. Production of antheridia exhausts the thallus, as also do fertilization and development of an embryo. In degenerating thalli part or parts may return to activity and develop lobes with normal functions. A. G.

Selaginella Wildenovii.—BERTRAM DONALD BARCLAY ("Origin and Development of Tissues in Stem of *Selaginella Wildenovii*," *Bot. Gaz.*, 1931, **91**, 452–61, 19 figs.) Investigation shows that the stem of *Selaginella Wildenovii* grows by means of a tetrahedral apical cell. The endodermis, pericycle, and vascular strand have a common origin and are all stelar. The endodermis forms the outermost layer of the stele. The endodermis and pericycle arise from a common initial. Elongation of the endodermal cells and formation of air spaces are explained by the mechanics of differential cell growth. The protoxylem differentiates first in the leaf-traces and later in the stem. The protophloem differentiates slightly later than the protoxylem. A. G.

Rarotonga Ferns.—EDWIN BINGHAM COPELAND ("Rarotonga Ferns, collected by Harold E. and Susan Thew Parks," *Univ. Calif. Pub. Bot.*, 1931, **12**, no. 14, 375–81, 1 pl.). A list of 14 ferns collected in Rarotonga in May–July, 1930, by Mr. and Mrs. H. E. Parks. The flora of this, the largest of the Cook Island group, was published by Cheeseman in 1903. Six species new to science are now described, and critical notes are appended to most of the species enumerated.
A. G.

Oriental Pteridophytes.—EDWIN BINGHAM COPELAND ("Miscellaneous Oriental Pteridophytes," *Univ. Calif. Pub. Bot.*, 1931, **12**, no. 15, 383–418, 6 pls.). A list of 7 species of *Lycopodium* and 47 ferns, mainly from the Malayan and Pacific islands, including 18 descriptions of new species as well as a key to the genus *Araiostegia* Copeland (1927), and critical notes on many of the species included in the paper. A. G.

Bryophyta.

Antheridia of Marchantia.—EMMA N. ANDERSEN ("Discharge of Sperms in *Marchantia domingensis*," *Bot. Gaz.*, 1931, **92**, 66–84, 19 figs.). In *Marchantia domingensis* the cells of the antheridial cavity have, like the sperm mother-cells, mucilaginous walls with pentosan reaction, and also with a cellulose reaction before maturity, and a thin layer of cutin on the exterior wall. Apart from the antheridia, the disk and stalk of the antheridial branch give in their cell walls both a cellulose and a pectic reaction. The presence of sugar reactions in the antheridial peripheral cells or walls is questionable. Maltazone crystals are found in greatest number on the exterior region of immature antheridia, and occur also in tissue between and below the antheridia. Anthocyanin occurs in the cell walls lining the antheridial cavity, and may tend to increase diastase activity, katabolic activity, as well as pentosan formation, or it may function wholly in a mechanical capacity. Magnesium is found in the antheridial membrane, also sulphate in the basal part of the antheridium, but their significance is not clear. The discharge of the spermatogenous mass depends upon the following factors—the swelling of the cells of the antheridial membrane with imbibed water, the simultaneous swelling

of the spermatogenous cell walls, the turgidity of the pigmented lining cells, the external pressure of paraphyses or basal cells, and the tissue debris accumulating in the cavity. The principal factor is the cells of the antheridial membrane.

A. G.

Germination in Lophocolea and Chiloscyphus.—G. CHALAUD ("Germination des Spores et formation du Gametophyte chez *Lophocolea cuspidata* et *Chiloscyphus polyanthus*," *Ann. Bryol.*, 1931, **4**, 49–78, 4 figs.). The elaters of *Lophocolea* are homologous with spore mother-cells. The spores of *Lophocolea* and *Chiloscyphus* germinate without a rest-period; the former in conditions not too moist, the latter in moist places or in water. In *Lophocolea* fragments of exospore are found attached to the basal cells of the protonema, but not in *Chiloscyphus*. The form of the protonema depends on the culture medium. The protonemas are simple or ramified; in *Chiloscyphus* the cells may break asunder and set up a vegetative multiplication by growing into new filaments, each with a vegetative point. The growing point is a small mass of cells derived from the terminal cell, and is three-sided; it sets to work after a few perturbations. Rhizoids develop from superficial cells. The earliest leaves and amphigastria are unilobed, often bearing a mucilage-papilla; bilobed leaves come later. False dichotomy originates in the young segments; adventive branches are of exogenous origin. The cytology of the spore and protonema is more difficult, especially as regards the plasts.

A. G.

Philippine Hepaticæ.—TH. HERZOG ("Hepaticæ Philippinenses a Cl. C. J. Baker lectæ," *Ann. Bryol.*, 1931, **4**, 79–94, 4 figs.). A list of 55 hepaticæ collected in the Philippine Islands by the late C. J. Baker, including descriptions and figures of seven new species, and supplementary notes on others. A. G.

Jamaica Hepaticæ.—W. H. PEARSON ("Notes on a Collection of Hepaticæ from Jamaica," *Ann. Bryol.*, 1931, **4**, 95–112, 2 pls.). A posthumous paper, edited by H. C. Broome and Fr. Verdoorn, on the hepatics collected by Prof. F. O. Bower in Jamaica in 1909, mostly at or near Cinchona (4,000–5,000 feet alt.). Among the 26 species enumerated, eight are described as new. A. G.

Notes on Hepaticæ.—FR. VERDOORN ("Hepaticæ selectæ et criticæ, Series I (1930)," *Ann. Bryol.*, 1931, **4**, 123–39, 6 figs.). A series of critical notes by the author and others upon many of the more interesting species in this collection of hepaticæ from various countries. A. G.

Notes on Hepaticæ.—FR. VERDOORN ("Hepaticæ selectæ et criticæ, Series II (1931)," *tom. cit.*, 140–50, 6 figs.). A series of notes on the second series. Specially interesting is that by G. Chalaud upon *Fossombronia cristula* var. *Verdoornii*, a novelty from Java, which is carefully contrasted with *F. cristula* Austin and *F. Luetzelburgiana* Goebel. All these three have rudimentary elaters.

A. G.

Primordia of Starch Grains in Mosses.—ROBERTA MOHLING MA ("Starch Deposition in the Sporogenous Cells of Certain Mosses," *Bull. Torrey Bot. Club*, 1930, **57**, 525–32, 1 pl.). An examination of the large single chloroplasts of the sporogenous tissue of the Bryales in relation to the origin of starch grains. These resemble the saucer-shaped chloroplasts of *Selaginella apus* and those of *Anthoceros* and *Notothylas*. When treated with Flemming's triple stain, the plastids show red or blue staining bodies. In very young archesporial cells roundish red-staining bodies are seen; these become spindle-shaped when older, and are

associated with starch grains of the same size and shape, and the evidence points to the probability of these bodies being primordia of starch grains—to their being pyrenoids. Investigation of the plastids of the vegetative cells of mosses is far too difficult to yield results with certainty. A. G.

Mosses in Polarized Light.—J. Amann ("Étude des mousses au microscope polarisant," *Ann. Bryol.*, 1931, **4**, 1–48, 1 col. pl., 4 figs.). The author calls attention, in considerably more detail than in his previous article (*Rev. Bryol.*, 1923, 6), to the value of the polarizing microscope in the study of difficult mosses. As an instance of this, he cites the question whether *Didymodon cordatus* Jur. is of close kin with *D. luridus*. While he and H. N. Dixon expressed the opinion that it was closely akin, G. Dismier held the view that it is a subspecies of *D. rigidulus*. Examined in polarized light, the leaf of *D. cordatus* proved to have no affinity with *D. luridus*, and Dismier's opinion was confirmed. In the present article the author describes the method of using the polarizing apparatus, and discusses the facts obtained by a detailed examination of all the parts of mosses in polarized light. A. G.

Daltonia.—Edwin B. Bartram ("A Review of the American Species of *Daltonia*," *Bull. Torrey Bot. Club*, 1931, **58**, 31–48, 2 pls.). The American species of *Daltonia* occur mainly in the Andes of Colombia, with extensions to Mexico and the West Indies, and to Bolivia, Chile and Brazil. The type of the genus was found in Ireland over a century ago. The sporophyte characters are fairly constant throughout the genus. The vegetative characters are less stable. Some well-marked groups of species can be recognized, but the delimination of species is a more delicate matter. As a result of an exhaustive examination of the material contained in the principal herbaria, the number of American species is reduced to 18. Many species are reduced to synonyms, after careful comparison of the types described by Taylor, Mitten, Hampe, C. Müller, etc. The 18 species are figured and described afresh. A. G.

Mexican Mosses.—I. Thériot ("Mexican Mosses Collected by Brother Arsène Brouard, III," *Smithsonian Misc. Coll.*, 1931, **85**, no. 4, 1–44, 22 figs.). This third and last part of the study of Brother Arsène's Mexican mosses adds 44 new species and 18 not previously recorded for the country. The gatherings of Brother Arsène and Brother Amable have thus enriched the flora with more than 60 species. The Mexican flora now contains about 700 mosses, a great advance upon the total of 400 species recorded by Bescherelle in his Prodrome 60 years ago. A. G.

Thallophyta.

Algæ.

Nuclear Phases in Diatoms.—Lothar Geitler ("Der Kernphasenwechsel der Diatomeen," *Beih. Bot. Centralbl.*, 1931, **48**, I, 1–14, 1 pl., 7 figs.). In the diatoms the Pennales group have a zygomorphic frustule with a raphe or pseudoraphe, while the Centrales have a centric frustule with neither raphe nor pseudoraphe; in reproduction the Pennales produce no microspores as the Centrales do; in the Pennales auxospore formation is typically combined with a sexual act, in the Centrales apparently not so. The author cites the evidence of authors that the Pennales are purely diplobiontic. It is probable, but not proven, that the Centrales are diplobiontic; and in this connection there are two possibilities—either there is a reduction division before auxospore formation, as Persidsky thinks

—and this would be in complete harmony with the Pennales—or the reduction division occurs when the microspores are formed, as Hofker and P. Schmidt believe. Supposing that the microspores are gametes, there is pure diploidy; but, if not, there is antithetic alternation of generations. Intensive and continuous research is requisite to show whether this second improbable possibility is realized, or whether Hofker or Persidsky are right in their assumptions. In an appendix is an account of some observations made of the nuclear divisions detected in some samples of *Hydrosera javanica* gathered by F. Rutter in the Sunda Expedition of 1928–29.

A. G.

Spitzbergen Diatoms.—VITO ZANON ("Diatomee dell' 'Olga Strait.' Secondo contributo alla conoscenza delle Diatomee della Isole Swalbard," *Mem. Pont. Accad. Sci. Nuovi Lincei*, 1931, ser. II, **15**, 291–332, 1 pl.). The sample of material examined had been collected from the under-side of polar ice in Olga Strait, on the east coast of Spitzbergen, by Dr. Bonola in the Albertini Expedition. The sample is free from mud and sand, and is believed by the author to be a matter of diatoms which had risen towards the surface and become adherent to the lower surface of the ice—in a manner resembling the phenomenon called "mare sporco," where the surface waters are turbid with risen plankton. The list of diatoms determined amounts to 124 species, more than half of which are of marine and brackish nature, and the rest of freshwater origin; many of the forms are new records for Spitzbergen. The author recommends the employment of "Peridrolo" for the preparation of glacial diatoms; it is a concentrated form of hydrogen peroxide. He speaks well of "Euparal" as a medium for mounting the specimens —a preparation containing sandarach, oil of eucalyptus, paraldehyde, camphor and salol.

A. G.

Wall Formation in Spirogyra.—A. CONARD ("Sur la formation de la membrane chez certaines espèces de *Spirogyra*," *Comptes rend. Congrès National des Sciences, Bruxelles*, 1930, 1931, extrait 1–6). Certain species of *Spirogyra* have transverse walls furnished with an intramarginal circular flange both on the upper and the lower face. The formation of this curious flange was studied by Strasburger in 1882 and 1889, and by Behrens in 1890. The mode of development of this flange is carefully redescribed by the present author. At the time when nuclear division begins to take place, preparation is made for the building of a new transverse wall; a large annular cushion of granular substance forms itself against the lateral wall of the mother-cell just in the zone where the new cell wall is due to begin its growth. But this annular cushion remains passive and shows no sign of wall formation until the fibres of the nuclear spindle come into contact with it, whereupon the margin of the coming transverse wall quickly becomes obvious and soon the rudiment of the flanges. The latter serve as a resting-place for the annular cushion, and then the latter continues gradually to construct the transverse wall in centripetal fashion. Without entering into further details, it should be stated that the cushion is of cytoplasmic origin, becomes actively membranogenous under nuclear influence, and is limited to the formation of the middle lamella.

A. G.

Permeability of Chara.—RUNAR COLLANDER ("Permeabilitätsstudien an *Chara ceratophylla*. I. Die Normale Zusammensetzung des Zellsaftes," *Acta Bot. Fennica*, 1930, no. 6, 1–20, 1 fig.) It is not difficult to collect the pure sap from the large cells of *Chara ceratophylla* and analyze it. In the present paper the normal composition of this sap is investigated, and is compared with that of the

water in which the plant grew and also with that of some other plants (*Halicystis*, *Valonia*, *Nitella*) studied by previous authors. The various percentages are shown in a table, where *Chara ceratophylla* is found to take a place between *Valonia macrophysa* and *Nitella clavata*. In the cell sap of *Chara* all the ions are found to be in greater concentration than in the surrounding water. The total salt-contents amount to about 1·5 p.c., and since very little albumen (less than 0·1 p.c.) and other organic bodies are present, the salts cannot be combined with these constituents, as is also evident from the electrical conductivity of the sap. Also dialysis shows that the sedimentary mud of the water does not contain so high a salt-concentration as does the sap. There exists, therefore, a transference of salts from the dilute outer medium into the concentrated sap. A. G.

Nuclear Phases in Rhodophyceæ.—NILS SVEDELIUS ("Nuclear Phases and Alternation in the Rhodophyceæ," *Beih. Bot. Centralbl.*, 1931, **48**, I, 38–59, 5 figs.). The Rhodophyceæ are systematically a uniform group, in colour and especially in the peculiar carpogonium with its trichogyne and enclosed egg-cell, and in the immobile spermatia. The group displays great variability of vegetative form and very varied modes of development and spore-formation after fertilization. The author discusses the following aspects—the occurrence of reduction division at different places in the life-cycle; haplobiont and diplobiont are not the same as haplont and diplont; diplobiontic Rhodophyceæ probably have arisen from the haplobiontic ones by a delay of the reduction division; if haplobiontic and diplobiontic types arose the one from the other, is the haplobiontic really the primitive type? The evidence is against evolution in the opposite direction, and favours a progressive evolution from haplo- to diplobiontic; *Phyllophora Brodiæi* probably a reduced type; probable course of the evolution of the Rhodophyceæ; comparison with other classes of algæ. Some instructive diagrams of the life-history of certain algæ are given in illustration of the varied modes of alternation of generations in contrasted species. A. G.

Laurencia.—YUKIO YAMADA ("Notes on *Laurencia*, with Special Reference to the Japanese Species," *Univ. Calif. Pub. Bot.*, 1931, **16**, no. 7, 185–310, 30 pls., 20 figs.). A systematic account of the genus *Laurencia*, with an analytical key to the 65 species, descriptions of 14 new species and 2 varieties, and critical and descriptive notes on all the other species and varieties. *Laurencia* has always proved to be a troublesome genus to algologists, and badly needed to be monographed. The author began the investigation, in the herbarium of the University of California, by a study of the Pacific species, and later included the other species, visiting all the important herbaria in America and Europe, and examining the types or authentic specimens of the species. The genus is divided into four sections—Palisadæ with 8 species, Fosterianæ with 19, Cartilagineæ with 27, Pinnatifidæ 11. Most of the new species are from Japan. A. G.

Nuclear Phases in Phæophyceæ.—MARGERY KNIGHT ("Nuclear Phases and Alternation in Algæ," *Beih. Bot. Centralbl.*, 1931, **48**, I, 15–37, 6 figs.). An account of what is known of the varied life-cycles occurring in the Phæophyceæ, the extent of variation being illustrated by a series of examples—*Lithoderma fatiscens*, *Nemoderma tingitana*, *Dictyosiphon fœniculaceus*, *Pylaiella littoralis*, *Asperococcus*, *Ectocarpus virescens*, etc. The distinction between nuclear and morphological cycles is discussed, and evidence is quoted tending to show that the two cycles may coincide to give a regular type of life-history, or may occur quite independently of one another. These points are illustrated by reference

to culture experiments in general and to *Dictyosiphon fœniculaceus* in particular. A summary of the types of life-cycle shown by the Phæophyceæ is given in schedule and in diagram form. The fundamental type of life-cycle for the Phæophyceæ is discussed, and three possible lines of development from it are outlined. The author reaches the conclusion that at the foundations of all variations in life-cycle in the Phæophyceæ lies a primitive type with equally balanced diploid and haploid phases, and that all other types can be reached by modifications of either or both phases of the primitive type, or by interference at the critical phases of meiosis or syngamy. A valuable bibliography is appended. A. G.

Revillagigedo Algæ.—William Albert Setchell and Nathaniel Lyon Gardner ("Marine Algæ of the Revillagigedo Islands Expedition in 1925," *Proc. Calif. Acad. Sci.*, 1930, 4th ser., **19**, no. 11, 109–215, 12 pls.). A systematic account of the algæ collected by Herbert L. Mason and others during the Californian scientific expedition in 1925 to the Revillagigedo Islands in the Pacific Ocean, far out from the Mexican mainland and south of Lower California and Guadalupe Island. The westerly Clarion Island was found to be the best collecting-ground in the group, and yielded 29 species. But a larger return, 91 species, was obtained from Guadalupe Island, 600 miles to the north. The total collection comprises 116 species, including two new genera—*Masonophycus* and *Clarionea*—and 34 new species. A. G.

Fungi.

Water Moulds.—John Couch ("Observations on Some Species of Water Moulds connecting *Achlya* and *Dictyuchus*." "*Micromyces Zygogonii* Dang., Parasitic on *Spirogyra*," *Elisha Mitchell Sci. Soc.*, 1931, 225–50, 1 pl.; 231–9, 3 pls.). Couch here describes three species which are intermediate between *Achlya* and *Dictyuchus*. In the former genus the spores usually emerge from the sporangium in a hollow ball in which they encyst. In *Dictyuchus* they encyst within the sporangium, and on escaping leave a network behind, though in some cases there may be intercellular spaces or a considerable space may occur in the centre. In the three species described there are three types: (1) with a true net, (2) *Achlya*-like, but with later sporangia of a false net-type, and (3) all sporangia of the false net-type. These three species have been accepted by Couch as *Dictyuchus* species. In the second contribution (pp. 231–9) is described again *Micromyces Zygogonii* Dang., which has been found for the first time in America in the cells of *Spirogyra*. The cytology and development are described, and are considered to be nearly akin to that of *Synchytrium endobioticum*. Couch therefore classifies this organism in the family Synchytriaceæ. A. L. S.

Algal Parasite.—G. Huber-Pestalozzi ("Infektion einer *Mougeotia*-Population durch *Micromyces Zygogonii* Dangeard an einem alpinen Standort," *Hedwigia*, 1931, **71**, 88–93, 1 pl.). The parasite, a member of the Chytridineæ, was first found growing in *Zygnema* by Dangeard, and later in *Spirogyra*. Some new characters are noted—the lengthening of the parasitized cells, etc. In any infected alga, all the cells of the filament were attacked. A full description of the parasite and its development is given. A. L. S.

Study of Phytophthora.—Leon H. Leonian ("Heterothallism in *Phytophthora*," *Phytopathology*, 1931, **21**, 941–55, 7 text-figs.). Heterothallism was first discovered in this genus by Ashby, though doubts were raised later as to the significance of the "paired strains." Other workers have since proved the necessity of the pairing of hyphæ before the formation of oospores, though other species have, however, as certainly been found to be homothallic. Leonian

experimented on *Ph. omnivora*, which though mainly proving to be heterothallic, yet homothallic forms requiring other strains for the production of oospores were present, as also neutral forms which never formed oospores in any culture. Leonian has discovered also that oogonia cannot be perpetuated indefinitely; in about five generations the mated forms fail to produce oospores. He found also that the strains showed no specific differences, the mating being evidence of heterothallism, not of hybridization between different species. He worked with 48 strains, which, though not identical, were not specifically different. A. L. S.

Germination of Sclerospora.—W. H. WESTON ("Pharmacien Frechon and the Germination of *Sclerospora* Oospores," *Phytopathology*, 1931, **21**, 439–43). Weston recalls the publication, in 1884, of the germination of *Sclerospora* oospores observed by Frechon, who, however, was unable to follow further development. In 1930 Hiura again reported the successful germination of the resting spores of the fungus from cultivated millet in Japan, thus confirming a discovery made 50 years ago. A. L. S.

Zygospores of Pilobolus.—HANS KRAFCZYK ("Die Zygosporenbildung bei *Pilobolus cristallinus*," *Ber. Deutsch. Bot. Gesellsch.*, 1931, **49**, 141–6, 2 text-figs.). The author explains his methods of securing and culturing the *Pilobolus* till finally he obtained mycelium of opposite sexes, and thenceforth it was easy to obtain abundant zygospores and watch every detail of development: the process of approach of the gametangia and, finally, the breaking of the contact walls, with mixing of the protoplasm and the building of a common wall round the spore. He has described, as part of the zygospore formation, the increase or disappearance of oil-drops and vacuoles, the mixing of the plasma, and the passing into a resting stage of long duration. He notes also that there are no ornamentations on the outer spore wall as in other *Mucorini*, and that sexual organs and mature zygospores remain embedded in the substratum, the original substratum being goats' dung. The cultures were made on dung-agar. A. L. S.

Studies in Mucorini.—ADALBERT BLOCHWITZ ("Hydrotropismus und Phototropismus bei Schimmelpilzen," *Beih. Bot. Centralbl.*, 1931, **18**, 166–75, 3 text-figs.). The author gives results of his cultures of fungi in the dark and in the light. A careful description is given of culture media and of conditions of growth. In *Aspergillus glaucus* he found pronounced hydrotropism; conidiophores were seen to grow towards any available moisture. Instances are also given, in several species, of phototropism. The influence of darkness on growth is also described. Similar results were proved in *Rhizopus nigricans*. A. L. S.

Aerial Hyphæ of Moulds.—ADALBERT BLOCHWITZ ("Luftmyzelbildungen bei Schimmelpilzen," *tom. cit.*, 176–82, 3 text-figs.). Aerial hyphæ are those that rise above the substratum. They develop from conidial cultures, and the author sets forth the results of his cultures of *Penicillium* and *Aspergillus* spp. on media of different kinds and of varying moisture. A. L. S.

Colour of Moulds.—ADALBERT BLOCHWITZ ("Die Farbstoffe der Schimmelpilze," *Ber. Deutsch. Bot. Ges.*, 1931, **49**, 131–7). Blochwitz passes in review a considerable number of Aspergillaceæ and Mucorinæ, with notes as to their colour. He quotes instances, as in *Aspergillus ustus*, where the colour is changeable—growth substratum brown, aerial mycelium bright green, conidia clear brown, these different members of the species giving different colours to reagents. Other instances he cites, and finally warns systematists against creating new species on colour characteristics. A L. S.

Cytology of Ascomycetes.—K. Wakayama ("Contributions to the Cytology of Fungi. II. Cytological Studies in *Morchella deliciosa* Fr.," *Cytologia*, 1930, **2**, 27–36, 2 pls.). Wakayama, working at the Tokyo Imperial University, gives the results of his study on nuclear division in *Morchella*. He describes in detail the process of division in the ascus of *Morchella* : the young ascus at its first appearance from the ascogenous hypha is binucleate ; fusion occurs, followed by reduction division ; the second division is homotypic, giving rise to four daughter nuclei. In the third division he found clear evidence of the occurrence of further reduction or brachymeiosis, but he is unable to decide if that represents a true reduction, though the 12 chromosomes separate to 6 at each pole, and 6 chromosomes appear in the ascospore, where a typical mitosis takes place in the spore—6 chromosomes being observed, the spore becoming thus binucleate. A. L. S.

Study of Myriangium.—F. L. Tai ("Observations on the Development of *Myriangium Bambusæ* Rick," *Sinensia*, 1931, **1**, 147–64, 22 text-figs.). The fungus here described is a common parasite of the cultivated bamboo. It produces a sort of tubercle on the basal part of the leaf-sheaths at the nodes of small branches ; apparently little damage is done to the host plant. Tai has made a detailed study of the fungus as it appears on the host and in cultures, though no advanced stages were secured. The stromata with the ascigerous tissues are described, then the ascospores and their germination, and their peculiar and abundant budding within the ascus. The author finds that secondary stromata are continuously formed year after year. Pycnidia were also found on the stroma, probably a stage of the *Myriangium*. A. L. S.

Some Fungi on Bracken.—Euphemia C. Barnett (*Trans. Brit. Mycol. Soc.*, 1931, **16**, 85–6). The saprophytic fungus *Rhopographus filicinus* is well known on bracken stems. Barnett describes two types of pycnidia that were also present. Pycnidia A : Cultures have proved what was already surmised—that these were a stage in the life-history of *Rhopographus*. The other, and the most common, Pycnidia B : It was found in the tissues of fronds, petioles, and rhizomes. Cultures were made, and from the spores were developed perithecia of the *Mycosphærella* type, which determined the affinity, though quite mature specimens have not been seen. A. L. S.

Study of Ascomycetes.—C. W. Emmons and B. O. Dodge ("The Ascocarpic Stage of Species of *Scopulariopsis*," *Mycologia*, 1931, **23**, 313–31, 4 pls.). The authors have made cultural studies of two fungi. One of them, with the alternate stage *Scopulariopsis*, occurred as a superficial infection on the feet and legs of a Porto Rican. The ascocarp stage has been determined as *Microascus trigonosporus* n.sp. The ascogonium rises from a weft of cells, and the further development is described. The ascogenous hyphæ grow out in all directions within the fruiting body ; after spore formation the asci disappear and the spores escape as cirrhi. The second species, *Microascus intermedius* n. sp., was found on decaying strawberry roots. No secondary stage was found, but the dark-coloured ascocarps with ostioles and the internal development decided its inclusion in the genus *Microascus*, a member of the Plectascales. A. L. S.

Study of Cicinnobolus.—Chester W. Emmons ("*Cicinnobolus Cesati*, a Study in Host Parasite Relationships," *Bull. Torrey Bot. Club*, 1930, **57**, 421–41, 3 pls.). The above fungus has long been known as a member of the Sphæropsideæ, a parasite on another parasitic fungus, *Erysiphe*. The writer is in doubt whether there may be more than the one species, *C. Cesatii* ; even in a single collection

there is great variation in size, as the conditions under which it grows have effect on the shape and size of pycnidia and spores. *Cicinnobolus* kills the host fungus and then lives on the vascular plant. It forms pycnidia from within the conidia-bearing hyphæ of its fungal host. All stages of this development have been followed, and the pycnidial formation has also been followed in artificial cultures. Further work on the subject is promised. A. L. S.

Study of Cercospora.—UDAI BHAN SING ("Studies in the genus *Cercospora*," *Journ. Ind. Bot. Soc.*, 1931, **10**, 73–91, 2 pls., 11 text-figs.). Species of *Cercospora* (a genus of Sphæropsideæ) cause leaf-spot disease on various plants. These fungi usually grow well on artificial media. The author has made a cultural study of four species collected in the neighbourhood of Allahabad; he compares the different species, the form of the leaf-spots and the course of growth in the leaf-tissues. In the cultures the species varied as to rate of growth, etc. One saltant was observed; it was sterile, and grew more quickly than the parent culture. Spore septation varied according to the culture medium. A. L. S.

Cercospora Studies, II.—W. G. SOLHEIM and F. L. STEPHENS ("Some Tropical *Cercosporæ*," *Mycologia*, 1931, **23**, 365–405, 12 text-figs.). The authors have drawn their material from various localities, many of them in the Southern States of America. The aim, they state, is to give adequate descriptions; they leave groupings and comparisons to a later date. In several of the species the conidia were produced in chains, and they have considered this character as generic—*Ragenhildiana* Solheim, gen. nov., the spores are hyaline to dark brown. Four species are described, two of them not hitherto known. All species reported in the paper grew on leaves. A. L. S.

Entomogenous Hyphomycete.—F. A. MASON ("Entomogenous Fungi from a Derbyshire Cave: *Stilbella Kervillei* Lindau, newly recorded in Britain," *Journ. Bot.*, 1931, 205–7). The above entomogenous fungus has been found on flies, *Blepharoptera* spp., in France, Holland, Silesia, and now in England, and always in caves. The British specimen was found on insects collected in Cresswell Caves, and identified as *Stilbella Kervillei*. Another fungus from the same collection was identified as *Hirsutella* sp., possibly the conidial form of a *Cordyceps*. A. L. S.

Study of Cereal Rusts.—Sir ROLAND H. BIFFEN ("The Cereal Rusts and their Control," *Trans. Brit. Mycol. Soc.*, 1931, **16**, 19–37). The paper on Cereal Rusts was given as the Presidential Address to the members of the British Mycological Society during the autumn meeting at Whitby. The enormous economic importance of cereals, their long-known susceptibility to rusts, the "mildew" of early writers, and the various attempts to combat the evil, are recounted and discussed in the paper. A review is then given of the more virulent rusts—*Puccinia graminis*, *P. glumarum*, *P. triticina*, and *P. coronifera*, which are described from every possible aspect. The methods of controlling and dealing with the pests are then described. First among these was the destruction of barberry bushes—the alternate hosts of *Puccinia graminis*—and this because it had been noticed that the disease was most serious near the barberry trees. The beginning of an epidemic was also traced to heavy falls of dew, and smoke was suggested and used as a deterrent. Next the difference between wheats as to rust resistance was observed, and the less susceptible kinds were cultivated. This form of defence has been followed on various lines until at last, by Mendelian crossing and careful elimination of the progeny liable to disease, a considerable degree of success has been achieved, and encouraging signs of well-nigh complete prevention are abundant.

Sir Roland Biffen has described these experiments step by step, many of them carried out under his own supervision. Many side-issues are discussed in the paper, as, for instance, the value of early varieties, a valuable aid, as these wheats ripen before the rust has become virulent. Another suggestion is that in some cases there may be a toxic substance in the host that causes the death of the parasite. Rusts are a complicated group of organisms, the species passing from one host to another one very different, and also produce different, kinds of spores at different stages of the life-history. A. L. S.

Study of Rusts.—J. H. Faull ("*Milesina* Rusts on *Aspidium Braunii* Spenner," *Journ. Arn. Arboretum, Harvard Univ.*, 1931, **12**, 218–19). Examination of the rust found on the *Aspidium* host was carried out by Faull. He found that it was distinct from *Milesina vogesiaca*, previously recorded on *Polystichum Braunii*, with peridermal stages on species of *Abies*. The further stage of the new rust, which has been named *Milesina exigua*, has not yet been discovered. It was collected in Poland in 1913, and again in 1917, and the probability is that the peridermal stage also occurs on *Abies*. A. L. S.

South American Rusts.—H. S. Jackson ("The Rusts of South America based on the Holway Collections—IV," *Mycologia*, 1931, **23**, 332–64, 6 text-figs.). A large number of rusts, most of them on leguminous plants, have been examined and reported; the larger proportion are new to science, and have been fully described. The localities cited are mainly in Brazil. A few species are from Chili, Ecuador, Bolivia, etc. Many are new, and a number of genera are represented. A. L. S.

Pine Blister Rust.—V. Tubœuf ("Ist *Pinus Peuce* gegen den Blasenrostpilz immun oder für ihn nur wenig disponiert," *Zeitsch. (Pflanzenpath.) Pflanzensch.*, 1931, **41**, 369–70). After various researches with *Pinus Peuce* and with inoculation on and from the rust on various *Rubi*, Tubœuf has concluded that *Pinus Peuce* is not entirely immune from attack, though less easily infected than *P. Strobus* and *P. monticola*. A. L. S.

Blister-Rust Infestation.—Walter H. Snell ("The Kelm Mountain Blister-Rust Infestation," *Phytopathology*, 1931, **21**, 919–21). Snell gives an account of severe loss from blister-rust in an area of trees at the foot of Kelm Mountain, Warren County, New York. Up to 1920 there had been no loss. Since then rust has increased to almost total extermination of the pines. A description is given of the locality and of the condition that made for immunity in the first instance, and later to the attack of the fungus. A. L. S.

Spore Germination in Uredineæ.—J. M. Raeder and W. M. Bever ("Spore Germination of *Puccinia glumarum*, with Notes on Related Species," *Phytopathology*, 1931, **21**, 767–89, 3 text-figs.). *Puccinia glumarum*, the stripe rust, is one of the most destructive cereal diseases in Europe, but not so prevalent nor so fatal in America. The authors have made a study of germination of the spores, their viability, etc., the better to understand the natural history of the rust. Many experiments were made in a large variety of solutions and with different conditions of heat and moisture. Various stimuli—acids and alternating temperatures—were also tested. The highest percentage of uredospore germination was obtained in tap water: the spores were viable for 88 days. Comparisons were made as to the viability of teleutospores; it was found that the age of the spores affected the germination. A weak solution of various acids seemed to stimulate

germination, and abundant sporidia were developed when the teleutospores were germinated in an exposed drop of water on a glass slide. How these results affect the spread of rust disease is discussed. No æcidial stage has yet been proved. Hibernation of dormant mycelium also came under review. A. L. S.

Study of Oat Smuts.—C. S. Holton ("Hybridization and Segregation in the Oat Smuts," *Phytopathology*, 1931, **21**, 835–42, 4 text-figs.). By cross-cultures of smuts the author has proved that *Ustilago Avenæ* and *U. levis* are interfertile; monosporidial lines of opposite sex fuse in culture and produce smut on the host whether crosses are made inter- or intraspecifically. Holton has given a detailed account of his many experimental cultures and the results obtained, which all point to the same conclusion. A. L. S.

West Indian Smuts.—R. Ciferri ("Smuts Collected in the Dominican Republic by E. L. Ekman," *Arkiv Bot.*, 1931, **23**, n. 14, 1–29, 3 pls., 2 text-figs.). The smuts were collected during 1929–30 by Ekman alone or in conjunction with Ciferri. Species belonging to 14 genera were identified. A large number belonged to the genus *Cintractia*, several of them new to science. Diagnoses of these are given and also full descriptions. With regard to distribution, comparison is made with other islands, especially with Porto Rico. The same genera are found in several islands, with the exception of *Thecophora*, which has not yet been detected in San Domingo, though the host plant is abundant. The species listed by Ekman in Dominica number 14. In Santo Domingo only 33 have been determined.
A. L. S.

Study of Ustilago.—Laura Alma Kolk ("Relation of Host and Pathogen in the Oat Smut, *Ustilago Avenæ*," *Bull. Torrey Bot. Club*, 1930, **37**, 443–507, 4 pls., 21 text-figs.). The author gives a general *résumé* of the literature concerning smuts before proceeding to an account of her own observations. She infected oat seeds, from which the hulls had been removed, by dusting them with smut spores. An account is given of the various conditions of moisture, termpeature, etc. The seedlings emerged above the sand usually about the fourth or fifth day after planting; a few were examined daily until they were about 15 days old. The various stages of infection and further development were carefully followed, such as the point of entrance by the fungus into the seedling, and the further growth of the hyphæ within the host plant. In seedlings over a month old the mycelium of the fungus was found in the cone of the growing points. Special attention has been given to the point of infection: mycelium was found at an early stage in the coleoptile, in the space between the coleoptile and the first leaf, in the leaf itself, and in the tissues of the node. Intracellular as well as intercellular mycelium was demonstrated; in the tip of the growing point it was intercellular. Changes in the character of the hyphæ were noted, and the number of the nuclei in the cells.
A. L. S.

Study of Fomes.—Yoshiwo Yamano ("On the Morphology and Physiology of *Fomes applanatus* (Tr.) Gill. and its Allies," *Sci. Rep., Tohoku Imp. Univ.*, 1931, **6**, 199–236, 4 pls., 1 text-fig.). Yamano has made a complete investigation of this fungus—of its morphology and physiology. He found three types, among the 30 specimens dealt with, distinguished by differences in the tube layers: two forms with tissue between the tube layers, the third without that tissue; no other differences were noted. There follow a description of the sporophores and a detailed account of the spores—their form and colour, the warted walls and the variable size. The larger part of the study deals with the physiology: observations on

growth at various temperatures and on different media—firm or liquid—and the differences in weight of mycelial masses due to the character of the media. An account is given of the action of different enzymes on the fungus meal, prepared by inoculation of carrots, etc., with the hyphæ of the fungus. The results are set out in tabular form. As a result of these studies, the author decides that the group fungus *Fomes applanatus* includes not only that species, but *Fomes vegetus* and a form *leucostratus*. A. L. S.

Study of Ganoderma.—C. J. HUMPHREY and SIMEONA LEUS ("A Partial Revision of the *Ganoderma applanatum* group, with Particular Reference to its Oriental Variants," *Philippine Journ. Sci.*, 1931, **45**, 483–589, 36 pls., 1 text-fig.). The authors have given here an account of *Ganoderma applanatum* and allied forms, which are interesting on account of their wood-destroying properties, and also on account of their extensive distribution. They found a wide variation in these different forms, and they live on an immense number of hosts. *G. applanatum* they consider to be the form most commonly occurring in temperate zones, but that species and its near relatives form an intergrading aggregate difficult to split, as the characters vary. It is, however, proposed to retain *G. applanatum* and *G. lobatum* as distinct species, and to these they have given special attention; in the Philippines were found two varieties of the former—var. *tornatum* and var. *philippense*. Immense care has been taken to give due weight to all the characters—form of the sporophore, tubes, spores, etc., all of which are depicted on the numerous plates. A. L. S.

Studies in Ganoderma.—W. R. HADDOW (*Journ. Arn. Arboretum, Harvard Univ.*, 1931, **12**, 25–46, 2 pls., 1 text-fig.). This study was undertaken to clear up the confusion as to the determination of various species, and also of the genus *Ganoderma*. The author was incited to the study by finding a species resembling *G. lucidum*, but differing in the host and some other slight particulars. He finds that *Ganoderma* is a well-defined genus distinguished by a palisade corticular structure and a resinous cuticle; the morphological characters of the sporophore and special spore characters determine the species. He describes in detail four American species. A. L. S.

Fungi from the Congo.—ORESTE MATTIROLO ("Sertulum Fungorum Congoensium," *Bull. Jard. Bot., Bruxelles*, 1931, **9**, 95–8, 1 text-fig.). The small collection of fungi determined by Mattirolo were sent to him by Prof. de Wildeman. Among them he found a new species, *Scleroderma pantherinum*, with a brown outer skin and brown spores. Two specimens only were sent from "Banalia," in a shady forest rich in humus, and the author asks Congo botanists to send more. A. L. S.

New Bovista Species.—HEINRICH LOHWAG ("*Bovista membranacea*, eine neue Art aus Ostafrika," *Oesterr. Bot. Zeitschr.*, 1931, **80**, 177–89, 1 pl., 4 text-figs.). The fungus was collected by Wettstein on Kilmandjaro. It bears some resemblance to *Bovista nigrescens*, but differs in certain characters, as, for instance, in the thin peridium, in the dark colour of the capilitium, and in the irregular warted hyphæ. A. L. S.

Micromycetes Philippinensis. Series secunda.—H. SYDOW and F. PETRAK (*Ann. Mycol.*, 1931, **29**, 145–279). This second contribution to the fungal flora of the Philippine Islands is a record of large collections belonging to Uredineæ and the smaller Ascomycetes, Pyrenomycetes and Sphæropsideæ. Many new species

are described, and nine new genera. Many of the fungi are parasitic on the higher plants. A. L. S.

Fungi from San Domingo.—R. CIFERRI ("Mycoflora domingensis exsiccata," *tom. cit.*, 283–99). One hundred specimens are included in the paper, representing 95 species of microfungi. Localities are recorded, the host plants of the parasitic species, and various biological notes. A number of species new to science are diagnosed by Cifierri, and parts of the type specimens are included in the issue. A. L. S.

Irish Fungi.—ARTHUR E. MUSKETT, E. NORMAN CARROTHERS, and HUGH CAIRNS ("Contributions to the Fungus Flora of Ulster," *Proc. Roy. Irish Acad.*, 1931, **40**, 37–55). The writers have brought the list of Ulster fungi up to date, and find that they number 595 species; many of those recorded are new to Ulster. The Basidiomycetes—agarics and polypores—are the most abundant. Among Micromycetes, Uredineales and Discomycetes are the most numerous. A considerable number of Phycomycetes and Fungi Imperfecti are included, especially those causing disease. A. L. S.

British Mycology.—E. M. WAKEFIELD ("The King's Lynn Foray," *Trans. Brit. Mycol. Soc.*, 1931, **16**, 1–5). The foray at King's Lynn was held in spring, and, as usual at that time of year, microfungi were more abundant than the larger forms, though these also were not lacking. A list of the fungi found in the district is given. A. L. S.

The Whitby Foray.—E. M. WAKEFIELD (*tom. cit.*, 7–15). The season (mid-September) proved unusually good, and the woods in the neighbourhood of Whitby —Mulgrave and Arncliffe woods—yielded a large amount of interesting material. The complete lists are very long and varied. A list of mycetozoa is appended. A. L. S.

Fungi Exhibit.—E. ULBRICH ("Die Ausstellung heimischen Pilze in der Schau-Abteilung des Museums," *Notizblatt Bot. Gart. Mus., Berlin-Dahlem*, 1931, **11**, 180–98). Ulbrich gives the aim of the exhibitors—to provide a representative collection of fungi for the public hall of the museum. He gives not only a list of the fungi selected for exhibit, but the methods employed to preserve them so as to retain shape, colour, etc., and recounts also the difficulties encountered in selecting the groups that would be most appreciated. A. L. S.

Study of Red Yeasts.—KAZUO OKUNUKI ("Ueber die Beeinflussung des Wachstums der Schimmelpilze durch die von Rosahefe gebildeten Stoffe," *Jap. Journ. Bot.*, 1931, **5**, 401–55, 1 pl., 6 text-figs.). The author has demonstrated the existence in red yeasts of two substances—one fatal to fungus growth, the other acting as a stimulant to growth. He describes his methods of research, and gives a list of the fungi—mostly *Aspergillus* spp.—and of the yeasts. He proved that there was a substance which, though killed by boiling, reacted adversely on fungus growth, while certain yeasts (beer yeasts and *Aspergillus Oryzæ*) were unaffected. After prolonged cultures, it was found that the poisonous substance disappeared and a substance was left that accelerated growth. Descriptions of the methods used to determine the character of these substances are given, and of the different tests and reactions of the yeasts. He has distinguished them as X and Y substances, and has compared them with others from different fungi. A. L. S.

Temperature Relations of Fusaria.—Kogo Togashi ("Cardinal Temperatures of Pea-wilt *Fusaria*," *Jap. Journ. Bot.*, 1931, **5**, 385–400, 1 text-fig.). There are three species of *Fusarium* associated with pea-wilt in Japan. Experiments were made with these and with another species reported to cause pea-wilt in America. The fungi were grown in incubators at temperature increases of 5° interval; measurements were made daily of the increase of the mycelial mats. Statistics of these cultures are recorded. The American species, *Fusarium Martii* var. *minus*, was found to be the most thermophilic of the group; it showed a higher maximum temperature growth than the others. They all grew vigorously at a comparatively wide range of temperature, though the range for sporulation was narrower than for mycelial growth. In one of the species, *F. arthrosporoides*, no sporulation occurred during the experiments. A long list of literature is cited. A. L. S.

Fungi on Insects.—T. Petch ("Notes on Entomogenous Fungi," *Trans. Brit. Mycol. Soc.*, 1931, **16**, 55–75). Petch remarks that though one thinks of entomogenous fungi as growing on insects in the ground, such as *Cordyceps* species, yet greater numbers in the tropics are to be found on insects attached to leaves of trees and shrubs—not only scale insects on the upper surfaces, but also on insects attached to the under-side. Again, he notes that, after the death of the infected insect, the fungus decays, and its end may be hastened by other fungi or by mites and insects. It is not exactly known if the superparasitic fungi that have been determined are confined to these hosts or are merely common saprophytes. Petch has given an account of all such fungi in the tropics and elsewhere: species of *Beauveria* are not uncommon in England. A number of new species are described, and one new genus, *Ophiocordyceps* Petch. It differs from *Cordyceps* in the spore characters. A. L. S.

Septobasidium and Aspidotus.—John N. Couch ("The Biological Relationship between *Septobasidium retiforme* (B. & C.) Pat. and *Aspidotus Osborni* New. and Ckll.," *Quart. Journ. Microsc. Sci.*, 1931, **74**, 383-437, 5 pls., 60 text-figs.). The fungus *Septobasidium* is allied to the Thelephoraceæ; there are some 70 species that grow on bark or leaves and, as a rule, do not penetrate to the tree tissues. Most of the species live in close association with scale insects, and Couch has here published a life-history and development of *Septobasidium retiforme* and its constant associate, the scale insect *Aspidotus Osborni*. Couch considers the relationship to be a symbiosis: the insect sucks juices from the tree; the fungus provides much-needed shelter for the insect, but lives on its exudations or on the insects which are parasitized by it at an early stage. Certain insects born in April and May escape parasitism, and reproduce their kind in July. The whole history of growth of fungus and insect has been followed in detail: a number of the insects are finally killed and used up by the fungus; others, though infected, may digest the fungal haustoria and survive, while others are free from infection. The fungus provides a home and protection for the scale insects. A. L. S.

Fungi Pathogenic to Man.—J. Ramsbottom (*System of Bacteriology in Relation to Medicine*, 1931, **8**, 11–70, His Majesty's Stationery Office). The section of this study of medical organisms deals principally with the fungi that cause disease. The author begins by a general account of the various families into which fungi are divided, many of them harmless growths so far as disease is concerned. Various aspects of fungal life are then discussed—their reproduction, their behaviour in cultures, etc. Ramsbottom then shortly describes the different fungi from what are considered the lower groups onward, discussing in each group the species that cause disease. It is in the "Fungi Imperfecti" that are found

most of the pathogenic forms. This is a very large group arranged in three divisions, but only the last, the Hyphomycetes, give rise to disease: these are discussed at length under the diseases caused by their growth on men or on animals. Correct determination requires culture of the organism, and the methods of culture are described, with a classification of these difficult forms, as a considerable aid to identification. The pleomorphism, so puzzling to the worker, is discussed, and finally a short section on physiology and the enzymes that are formed by the parasites is given. A. L. S.

Studies of Micro-organisms.—HAROLD RAISTRICK and OTHERS ("Studies in the Biochemistry of Micro-organisms," *Phil. Trans. Roy. Soc.*, 1931, **220**, i–iv, 1–367, 2 pls.). The biochemical examination of micro-organisms—belonging to the Schizomycetes (bacteria) and Eumycetes (true fungi)—was undertaken by H. Raistrick and various co-workers to investigate the chemical products of the above living organisms, mainly with regard to their importance in fermentation processes. In a historical survey the authors note oxalic acid as the first to be recognized, in relation to fungi, as a fermentation product of *Aspergillus niger* from sugars. More recently discovered as artificially formed by the action of moulds, are citric acid, fumaric acid, malic acid and succinic acid. Ethyl alcohol and other substances can also be formed by mould agents. The scientists engaged on this work undertook an examination of particular series of microfungi. In some cases similar acids were produced by different fungi; in other cases the moulds tested formed only one type of product. A resemblance was noted between the acids formed and the lichen acids, the formulæ being largely similar. The work done is set out in 18 parts, each undertaken by a group of the investigators, and the different moulds, the culture substances, and the methods employed are fully described, the resulting products being given in elaborate tables. *Aspergillus* and *Penicillium* occupied attention first of all. Later the study was extended to a large series of fungi—a few Ascomycetes and Smuts, with a number of Hyphomycetes; these were grown on glucose and the results tabulated. It is noted that *Fusarium* spp. had the property of producing large quantities of alcohol from glucose, and might be used on waste vegetable matter to obtain supplies of alcohol. Other points examined were the special characteristics and products of *Penicillium digitatum* and of *P. italicum* when grown on glucose, these fungi being responsible for the rot of *Citrus* fruits. The former produced ethyl alcohol and a new polysaccharide, the latter a substance that coloured purple on the application of ferric chloride. This abstract gives only a slight sketch of the vast amount of detail and of the exact results secured. A. L. S.

Antibiosis of Bacteria to Fungi.—DELIA E. JOHNSON ("The Antibiosis of Certain Bacteria to Smuts and Some Other Fungi," *Phytopathology*, 1931, **21**, 843–63, 6 text-figs.). It had been noted, in previous investigations, that gall production (with the presence of bacteria) was considerably affected by the presence of Smuts; also that bacteria could be isolated that were antibiotic to species of Smuts. An account is given of a series of experiments to define the conditions of influence. Four types of bacteria are discussed, which were found to be antibiotic to fungi—a coccus, a motile non-spore-bearing rod-like bacterium, a motile bacterium and a Myxobacterium. In the course of the investigation, though Smuts were mainly dealt with, other fungi, such as *Penicillium*, were found to be inhibited by the presence of certain bacteria. A study was made of the enzymes of the bacteria to test their reaction to the chemical constituents of the cell wall. Some bacteria were found to dissolve the cell wall of the Smuts, while other bacteria, with the

same type of enzymes, failed to do so, suggesting some unknown antibiotic property. *Long cultivation on artificial media finally destroys the antibiotic principle.* Experiments with a Myxobacterium proved that infection of Smuts was inhibited to some extent. A list of literature bearing on the subject is appended.

A. L. S.

Bacteria in Relation to Smuts.—R. H. BAMBERG ("Bacteria Antibiotic to *Ustilago Zeæ*," *Phytopathology*, 1931, **21**, 881–90). Bamberg gives an account of investigations into the factors affecting the growth of *Ustilago Zeæ* on corn plants. It had been first noted that young corn plants seldom became infected, and that in older plants artificially inoculated the fungus died off. Near the area of inoculation discoloured areas were observed, and from a culture of these areas bacteria were isolated that were inimical to the Smut fungus. Further experiments proved that sporidia of *Ustilago Zeæ* failed to multiply in the presence of a culture of bacteria from corn plants, and that corn plants already infected with the Smut would not produce galls from the bacteria. Various experiments with bacteria were carried out: ten cultures of bacteria had a deleterious effect on the Smut in culture, while five others had no effect. *Ustilago Zeæ* was less virulent on the corn plant by the association with bacteria, and also where these were injected into the corn plant before the infection experiments. A filtrate from the bacterial cultures had no effect on the development of the Smut on the plant or in cultures, so that the destructive action is associated with the presence of the bacteria.

A. L. S.

Nutritive Saltation in Fungi.—H. CHAUDHURI (*Journ. Ind. Bot. Soc.*, 1931, **10**, 134). The author gives his views as to the occurrence and nature of saltants in fungi. He finds that they are due to artificial culture processes: they revert to the original form when the culture medium is changed, or when they are transferred to their original hosts. Chaudhuri does not rule out cases of true mutation, which are, however, very rare. A. L. S.

Disease caused by Pythium.—L. L. HARTER and W. J. ZORMEYER ("*Pythium Butleri*—the Cause of Bean Wilt," *Phytopathology*, 1931, **21**, 991–4). In this paper is traced the disease as it appeared in field conditions. It begins as a water-soaked infection of the stem at about the soil line, and progresses upwards. It has been observed at Colorado and Virginia, cultures proving the identity of the organism. The fungus, though not previously found on beans, is widely distributed, causing especially the damping-off of seedlings. A combination of high temperature and humidity provides ideal conditions for the growth of the *Pythium*, though the high temperature is the more important factor. A. L. S.

Sugar Beet Disease.—ALEXANDER WENZEL ("Beiträge zur Kenntniss der Blattfleckenkrankheiten der Zuckerrübe," *Phytolog. Zeitschr.*, 1931, **3**, 519–29, 10 text-figs.). Wenzel gives here additional information as to the progress of the sugar beet leaf disease caused by *Cercospora beticola*. In artificial cultures he found that the fungus developed well and produced chlamydospores. An examination of the infected plants proved that those most abundantly supplied with potash suffered most; next, those lacking in nitrogen and in phosphorus. Attention is further given to accompanying infections, such as *Ramularia Betæ*. The *Ramularia* fungus has been considered a serious disease in Denmark, not so much so in Germany. The mischief caused by *Alternaria tenuis* was also studied; it was proved that that fungus was only a weak parasite, and practically harmless. A. L. S.

Fusarium Wilt of Peas.—MAURICE B. LINFORD ("Transpirational History as a Key to the Nature of Wilting in the *Fusarium* Wilt of Peas," *Phytopathology*, 1931, **21**, 791–6, 2 text-figs.) The paper discusses the rapid wilt of peas due to *Fusarium* attack, evidenced by an excessive loss of water from the leaves. This is thought to indicate the loss of the normal powers of water retention by the leaf protoplasts rather than from a diminished water-supply, and this especially in young plants. A. L. S.

Studies of Fusarium Wilt.—MAURICE B. LINFORD ("Studies of Pathogenesis and Resistance in Pea Wilt caused by *Fusarium orthoceras* var. *Pisi*," *tom. cit.*, 797–826, 9 text-figs.) The paper includes results obtained by the author in questions of infection and factors which control it, and discusses possible means of resistance. It was found that the disease was induced by the fungus without the aid of other micro-organisms, and that the wilt developed rapidly where the soil was heavily infected with the *Fusarium*. The changes induced by the disease are described —dwarfing, rigidity, hypertrophy of the lower stem internodes, and rolling of leaf laminæ, etc., indicating unbalanced nutrition. The wilting is the culmination of a long series of changes induced by the influence of the fungus. A. L. S.

Wound Inoculation in Fusarium Wilt.—MAURICE B. LINFORD ("Wound Inoculation in Relation to Resistance in the *Fusarium* Wilt of Peas," *tom. cit.*, 827–33, 2 text-figs.). By inoculation of young pea plants with the wilt disease, *Fusarium orthoceras* var. *Pisi*, through wounds in aerial parts, symptoms were obtained which partially simulated those typical of the pea-wilt disease; but the low percentage of infection so obtained indicated a specialized parasitism and also a mild degree of resistance to the invasion of aerial parts. This also proves that the wilt fungus has not the same virulence without the preliminary alterations in the host physiology associated with the usual root infection. A. L. S.

Disease of Cotton Seedlings.—FRANZ FORSTENEICHNER ("Die Jugendkrankheiten der Baumwolle in der Turkei," *Phytopathologische Zeitschrift*, 1931, **3**, 366–412, 22 text-figs.) The research was carried out first in Turkey (Adana), later in Berlin. The plants are attacked by several different fungi, and the author has studied each and described his results. (1) *Rhizoctonia Gossypii* n. sp. attacks the hypocotyl about a centimetre below the soil. There is a variety of this fungus (var. *ægyptica*) which differs in certain details. The species made no fusion with *Rhizoctonia Solani* in cultures, while the variety fused readily. (2) *Rhizoctonia nigricans*: this species attacks the roots and the seed hairs. (3) *Fusarium moniliforme*, also occurring in seed-beds, attacks the plant as it emerges from the seed, and also, at a later stage, the hypocotyl; Forsteneichner considers it, however, to be generally a "following" parasite attacking plants already damaged. (4) *F. Scirpi* attacks the first rootlets, otherwise it resembles *F. moniliforme*. (5) *Alternaria humicola* var. *Gossypii*, a true parasite of cotton, causing serious damage to the roots. It is concluded that appropriate care of the soil, as regards temperature and humidity, would do much to combat the parasites. A long list of literature dealing with the subject is given, and descriptions of the figures depicted on seven plates. A. L. S.

New Canker Fungus.—L. N. GOODDING ("*Didymosphæria oregonensis*, a New Canker Organism on Alder," *Phytopathology*, 1931, **21**, 913–21, 2 text-figs.). The fungus causing canker on several species of *Alnus* has been found to be general in Western Oregon, and is also reported from other north-western districts. It

forms bands and swollen cankers on the boles and branches of alders, though it does not kill the trees. Perithecia are numerous within the canker, and examination proved the organism to be a new species of *Didymosphæria*. The relation to other known species is discussed. A. L. S.

Leaf Disease of Ledum.—S. M. ZELLER and J. W. DEREMIAH ("An Anthracnose of *Ledum* caused by a Species of *Elsinoë*," *Phytopathology*, 1931, **21**, 965–72, 3 text-figs.). The fungus here described attacks leaves, younger branches, and flower pedicels, sometimes also calyx and capsules. It was found mainly in Oregon on *Ledum glandulosum*, an ericaceous shrub. A detailed description is given of the fungus, *Elsinoë Ledi*, which is associated with the disease. The development of the fungus in association with the host tissue has been followed. It causes an anthracnose, which disfigures the host plant. A. L. S.

Willow Disease.—R. W. G. DENNIS ("The Black Canker of Willows," *Trans. Brit. Mycol. Soc.*, 1931, **16**, 76–86). There has been considerable doubt as to the cause of Black Canker of willows or Willow Scab, which has usually, in the past, been ascribed to *Fusicladium saliciperdum*. The disease was again examined by Nattrass at Long Ashton in 1928, and he determined the parasitic fungus as *Physalospora Miybeana* Fukushi; the *Fusicladium* was present, but apparently harmless. Dennis has evidently succeeded, by cultures and inoculations, in identifying the *Physalospora* as the cause of the disease. He described his experiments and the results obtained. A. L. S.

Seed Transmission of Cowpea Fusarium Wilt.—JAMES B. KENDRICK (*Phytopathology*, 1931, **21**, 979–81, 1 text-fig.). The wilt of Cowpeas (*Vigna sinensis*) is caused by *Fusarium tracheiphilum*. It causes much damage wherever cowpeas are grown, and this study was undertaken to find out how the disease was spread. Kendrick gives an account of his examination of the Cowpea seeds; he found very little evidence of the presence of mycelium within the seeds. The fungus, however, persists on the outer coats of the seed, and is probably thus the agent of transmission. Seeds a year old gave a high percentage of infected plants. A. L. S.

Lichens.

American Lichens.—JOYCE HEDRICK ("Lichens from the State of Oklahoma," *Michigan Acad. Sci., Arts & Letters*, 1931, **13**, 101–10). Oklahoma is one of the south-western States of the Great Plains region. The author describes the territory, the weather conditions, etc. The collection is by no means exhaustive. There is only one Pyrenolichen and one Graphidaceæ. Cladoniæ were rare; *Parmelia* spp. and *Physcia* spp. were the most common foliose forms. In all, 22 genera are represented in the list, with 59 species and subspecies. A. L. S.

British Lichens.—P. G. M. RHODES ("The Lichen-Flora of Hartlebury Common," *Proc. Birmingham Nat. Hist. Philos. Soc.*, 1931, **16**, 39–43). Rhodes approaches the subject under three associations: (i) Heathland, (ii) Corticolous, (iii) Saxicolous. The whole district, as regards lichen growth, has been affected by industrial conditions. "The smoke of Birmingham affects the lichens within a distance of at least thirty miles," and the air of the Common has become more polluted recently by the smoke emitted from the new electrical generating station. *Lecanora conizæa* and *Lecidea uliginosa* are noted as specially resistant to smoke, the former having a more or less leprose thallus, the latter a quick-growing soil lichen. A. L. S.

Notes on Cornicularia.—BERNT LYNGE (" *Cornicularia divergens* Ach. found Fertile in Europe," *Nyt. Mag. Naturvid. Skaberne*, 1929, **67**, 131–6). The lichen *Cornicularia* (*Alectoria*) *divergens* is closely allied to *A. aculeata*. It has been recorded as bearing apothecia, only with certainty from N.E. Asia. It is a circumpolar plant, and has been recently collected, on the Dovre mountain, bearing " several fine apothecia." Lynge discusses the systematic position of *Cornicularia*.

A. L. S.

Spanish Lichens.—L. CRESPI (" Notas liquenológicas," *Bol. Real. Soc. esp. Hist. Nat.*, 1930, **30**, 261–9). The aim of the writer is to arrange the species of *Rhizocarpon* in systematic order. He gives a list of nine species, with descriptions and critical notes. The localities in Spain and the collectors are given.

A. L. S.

Study of Lichen Tissues.—O. V. DARBISHIRE (" Observations on the Margin of *Pertusaria communis** (L.) D.C.," *Trans. Brit. Mycol. Soc.*, 1931, **16**, 38–54, 2 pls.). Darbishire gives a history of the terms that have been used to distinguish the outer primary margin of hyphæ—the prothallus, or, as he prefers to call it, the protothallus. The more advanced tissues derived from the protothallus are termed the " metathallus," in which secondary growth occurs. The protothallus spreads over the substratum—in this case the bark of trees—in a centrifugal direction; the component hyphæ are embedded in a matrix that readily absorbs water and forms a thick and rather tough limiting membrane at the outer edge. This margin is in time pierced by growing hyphæ that extend the lichen plant in space, and in time form a further margin—probably indicating seasons of growth. On the lower side hyphæ grow downwards and pierce the substratum. Other hyphæ take an upward direction, gonidia arrive and are incorporated, and the thallus is gradually built up. The medullary hyphæ are loosened as air-passages are formed to supply the needs of the gonidia. From careful observations Darbishire is convinced that primarily gonidia do arrive from the open, that the process goes on, and that such gonidia have been traced by him into the metathallus. The taking in of algæ is a constant features of cephalodia, and, in *Peltigera aphthosa*, Darbishire has pointed out that *Nostoc* cells are added to the thallus near to the margin. Darbishire looks on the symbiotic combination of the two constituents as a " mutual parasitism " : " the alga, by its need for air, light, water and food material, influences the growth and general activities of the fungal hyphæ in such a way that these wants are satisfied. If they are not satisfied, it is the lichen that dies and not, as a rule, the alga or fungus." The biological result of this close association is the green lichen. It is also pointed out that, though there is considerable differentiation of tissues in the lichen, these are not so morphologically fixed as are epidermis, cortex, and stele in the higher plants. A. L. S.

* *Lichen pertusus* was the name given to this lichen by Linné, and the accepted name, following botanical rules, is *Pertusaria pertusa*.

Lichen Catalogue.—ALEX. ZAHLBRUCKNER (" *Catalogus lichenum universalis*," 1931, **7**, parts 41–9, 641–784). This issue marks the end of a long work—a catalogue in systematic order of all recognized lichens, to the number of 13,885 species, with their innumerable synonyms. The systematy of lichens has not stood still, and many new species have been determined during the course of the work. There are seven volumes, invaluable to all students of lichenology. The author has appended a number of doubtful genera, such as *Lepraria*, *Byssus*, etc., with the species ascribed to them, and an enumeration of species of the old genus lichen, the significance of which is lost or altogether doubtful. A. L. S.

Physiology of Lichens.—J. B. Cuthbert ("Some Notes on the Physiology of *Teloschistes flavicans*," *Trans. Roy. Soc., S. Africa*, 1930, **19**, 27–44, 1 pl., 6 text-figs.). The author remarks on the ready response of lichens to environmental conditions. *Teloschistes flavicans* has a maritime distribution; it grows in tufts on bushes, rarely on dead wood or rock; it is yellow in sheltered spots, deep orange in sunlight, and may occur in masses 12 inches across. The lichen was examined as to its water content, the production of parietin, and the effects of salt in causing weathering. For water content he examined the methods of absorption and found, after immersion of the frond in eosin water, that the stain had penetrated rapidly and equally from all parts of the periphery; it was also found, by the same method, that water did not rise up through the frond; moisture was also largely absorbed from saturated air. As to the presence of parietin, it was most abundant in full sunlight. Cuthbert found also that it occurred in the fine ultimate branches where no algæ were present, and also in the outer rind of the frond, at a distance, therefore, from the gonidial layer. It was further observed that very young thalli (thread-like structures without algæ) also contained parietin, and as regards the influence of sunlight, portions kept in the dark for over three months showed no diminution of parietin. Cuthbert then goes on to describe the weathering conditions, due mainly to salt deposit from the sea. Calcium oxalate crystals were also abundant in weathered fronds, and are massed mainly in the medulla; the white specks on weathered fronds are exposed crystal deposits. A. L. S.

Lichens of the Erzgebirge.—Oskar Klement ("Zur Lichenflora des Erzgebirges. Die Umgebung von Komotau," *Beih. Bot. Centralbl.*, 1931, **48**, Abt. II, 52–96). Klement has studied the lichen flora of the Erzgebirge from the Bohemian side. He divides the territory into (1) the lower "Vorland," up to 400 m., with a rainfall of 100, which includes the cultivated lower lands; (2) the lower slopes, from 400 to 750 m., rainfall 100–160, a region of mixed woods and meadows; (3) the upper reaches, over 750 m., rainfall 160, a region of pine forests and high moors. Klement gives an account of the geological formations as somewhat monotonous—gneiss on the summits, lower down mountain debris with lime and sand deposits. The richest in lichens were the high summits; on the lower lands lichen growth was interfered with by cultivation, etc. A series of associations are described—epilithic and epiphytic, followed by the association of soil lichens such as *Polytrichetum piliferæ* mostly with *Cladoniæ*, a *Callunetum* with numbers of *Cetrariæ* and *Cladoniæ*, and a *Festucetum ovinæ*, again mostly *Cladoniæ*. The second part of the work consists of a list of all the lichens found, belonging to 20 families. It is noteworthy that only one *Caloplaca* (*C. murorum*) is listed, and no members of the Graphidaceæ. The altitude and nature of habitat, as well as locality, are given. A. L. S.

Lichen Gonidia.—Feodor Elfving ("Weitere Untersuchungen über Flechtengonidien," *Acta Soc. Sci. Fenn.*, nova series 8, 1931, I, 1–30, 13 pls.). Elfving has published a new series of studies in support of his theory that the gonidia are budded off from the hyphæ of the lichen thallus; he claims to have again observed this phenomenon, and devotes considerable space to the disproving of the accepted view of symbiosis. The many plates are reproductions of microphotographs of thallus sections made by Elfving, and are published as proofs of his theory. He does not give any illustrations of the early stages of the budding of the green cells from the colourless hyphæ. He, however, accepts the fact that these green cells of presumed "fungal origin" may escape and live a free life.

A. L. S.

Lichens from the Abruzzi.—A. GINSBERGER ("Beitrag zur Kenntniss der Flechtenflora des Gran Sasso-Gebietes (Abruzzen)," *Hedwigia*, 1931, **71**, 206–14). The lichens were collected by Dr. August Ginsberger in 1912, mostly on Corne Grande, rising to a height of 2,914 m.; in other places at lower altitudes. They were examined and determined by Julius Steiner (since passed away) and by A. Zahlbruckner. A new genus of Ephebaceæ has been described: it grew within the limestone, showing a granular coating on the surface. The gonidia belonged to the blue-green algæ. The apothecia were lecanorine, the spores small, simple, and colourless, then brownish. A considerable list of crustaceous genera and species follows, many of them on quartz. The altitude is added in each case.

A. L. S.

Italian Lichens.—CAMILLO SBARBARO ("Licheni nuovi o interessante," *Arch. Bot.*, 1930, **6**, 9–15). The lichens were mostly collected in Liguria by Sbarbaro and others. Nine species, new or with new varieties, have been determined by Bouly de Lesdain. Other species, new or interesting, collected at various times in the same district, are also recorded, "showing the number of lichens still to be found in Italy." A. L. S.

Study of Chiodecton.—FR. TOBLER ("Pilz und Alge bei *Chiodecton sanguineum* (S.W.) Wainio, eine grundsätzliche Erörterung über die Entstehung von Flechten," *Ber. Deutsch. Bot. Ges.*, 1931, **49**, 274–81, 4 text-figs.). In this second study of *Chiodecton*, Tobler gives an account of the examination of further specimens. He finds that the red chiodecton acid disappears in close contact with the alga, but reappears as the fungus frees itself from the alga, hence the red colouration found at the alga-free margin. Several types of gonidia have been found by him in the thallus, accompanied by some difference in the form of the hyphæ; he also notes the different coloured acid crystals, some more yellow than red, indicating a change in the acid. He considers that in this *Chiodecton* lichen is to be found a recent type of symbiosis, and that the fungus frequently lives independently of the alga, and also that it has not yet attained to fruit formation. The symbiotic condition is, however, the basis of development, and the hyphæ gain from the alga the impulse to further growth. Tobler cites a case where the fungus soared upward to a *Clavaria*-like development, rich in acids, without the alga, though that proceeded from a base including gonidia. A. L. S.

Mycetozoa.

King's Lynn Myceotoza.—H. J. HOWARD (*Trans. Brit. Mycol. Soc.*, 1931, **16**, 5–6). Howard reports that the district round King's Lynn proved very favourable, though previous wet weather had induced abnormalities in some of the species found. One of the most striking species collected was *Physarum psittacinum*, distinguished by purple, red, and orange colouring. The list of species collected is added. A. L. S.

Japanese Mycetozoa.—YOSHIKADZU EMOTO ("Die Myxomyceten der Sudmandschurei," *Bot. Mag., Tokyo*, 1931, **45**, 229–33, 3 text-figs.). The writer includes in his list a new species, *Physarum puniceum*, which he has described and figured. A. L. S.

TECHNICAL MICROSCOPY.

Microscopical Study of the Effect of Follicular Mange on Skins, Hides and Leather.—F. O'FLAHERTY and W. RODDY (*Journ. Amer. Leather Chem. Assn.*, 1931, **26**, 394–403) Follicular or demodectic mange is caused by the parasitic mite *Demodex folliculorum*, which is described in detail. The mites enter the skin of the living animal through the hair pockets, and from thence to the adjacent glands and the corium around the hair roots. With cattle and swine the hair itself is little damaged, and hence attack may not be apparent until after slaughter. The damage is largely centred upon the hair-pocket lining and the corium, resulting in raised areas over the grain. The scratching of the animals may also lead to bacterial infection. A series of microphotographs is given illustrating the damage and the method of migration of the mites. The damage to the finished leather through attack includes the following; (*a*) enlargement of the hair pocket, evidenced on the grain by enlarged pores; (*b*) direct grain damage; (*c*) difficulty in the scudding operation; (*d*) raised spots on the grain due to accumulated mites in spaces in the corium; (*e*) destruction of corium or true leather-forming fibres; (*f*) destruction of neighbouring structures; (*g*) decrease in strength of the leather; (*h*) hide substance losses due to both mange mites and bacterial infection. The mites appear to be easily killed after slaughter, death occurring after 24 hours in salt. They are also killed in 1½ days in a dry atmosphere and 3 days in a moist atmosphere. Preliminary experiments make it doubtful whether infection can occur from one salted skin to another, and from dead skin to living tissue. It is probable that all infection takes place while the tissue is living, and none during storage of the dead skins. The remedy, therefore, lies with the farming industry. A. H.

Use of the Microscope in the Tannery.—R. H. MARRIOTT (*Leather World*, 1931, **23**, 713). A general article stressing the importance of microscopical methods in tannery control. Hints are given regarding technique. Limed hide is best frozen in a freezing microtome in which CO_2 is used rather than ether. Wet sections should be mounted in Farrant's medium, and leather sections in Canada balsam.
A. H.

NOTICES OF NEW BOOKS.

Elementary Histological Technique for Animal and Plant Tissues.—By J. T. HOLDER, F.R.M.S. 1931. vii + 112 pp., 23 illustrations. Published by J. & A. Churchill, 40, Gloucester Place, Portman Square, London, W. 1. Price 7*s*. 6*d*.

Lehrbuch der Mikrophotographie und Mikroprojektion.—By Dr. med. KURT LAUBENHEIMER. 2nd edition, 1931. xii + 272 pp., 8 pls., 187 text-figs. Published by Urban & Schwarzenberg, Berlin. Price RM. 18.

Manuel de Police Technique.—By E. GODDEFROY, F.R.M.S. 1931. 313 pp., numerous illustrations. Published by Maison Ferdinand Larcier, 26–28, Rue des Minimes, Bruxelles.

Index Animalium.—By C. D. SHERBORN. 1930. Part XXIII, pp. 5703–5910. Part XXIV, 5911–6118. Published by the British Museum (Natural History), Cromwell Road, London, S.W. 7. Price 10*s*. each part.

Mikrokosmos. Zeitschrift für angewandte Mikroskopie, Mikrobiologie, Mikrochemie und mikroskopische Technik.—Edited by Dr. G. STEHLI. Vol. XXV, Part 1, Oct. 1931. 28 pp., 2 pls., 15 text-figs. Published by Franckh'sche Verlagshandlung, Stuttgart. Price RM. 1.

Microscope Record.—No. 24, September, 1931. 24 pp., 1 pl., 15 text-figs. Published gratis by W. Watson & Sons, Ltd., 313, High Holborn, London, W.C. 1.

Elements of Optical Mineralogy. An Introduction to Microscopic Petrography—Part I. Principles and Methods. By ALEXANDER N. WINCHELL. 4th edition, 1931. xii + 248 pp., 270 figs. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2. Price 21*s*. net.

This well-known text-book has now reached its fourth edition. Chapter I, which comprises the elementary conceptions of mineralogy, consists of five pages with three text-figures. This chapter is too brief to give the student a clear understanding of space lattices, crystal symmetry, and axial symbols. During the past decade, aided by the researches of F. E. Wright and others, there has been a tendency to make use of those optical characteristics which are capable of quantitative expression. These include optic axial angle, refractive index, bi-refringence, cleavage angle and extinction angle. It is natural, therefore, that these receive prominence in this book. With the aid of the universal stage, quantitative measurements of the optical elements of minerals in thin sections can be readily made. The author devotes about half a chapter to the use of the universal stage, and provides charts for making the necessary corrections. Chart No. 3 would be improved if the 10° intervals were subdivided further. For minerals in powdered form one of the most important properties is refractive index. Improved methods and technique, notably where the temperature of the immersing liquid and the wave-length of the light employed can be changed progressively, have enabled the mineralogist to determine the refractive index of a mineral in less time than formerly. Also the number of immersion liquids required is about 13, whereas Maschke's method necessitates about 60 liquids. The author describes these methods, and gives an illustration of the apparatus recommended by Prof. Emmons for this purpose. The laboratory exercises given in the book are designed to give the student training in the use of the petrographic microscope and its accessories, and should prove useful. It is to be hoped that in Volumes II and III of this work the author will present data which will enable mineralogists to make full use of the single and double variation methods of refractive index determination—not only the dispersion and temperature variations, but also the influence of varying proportions of elements such as iron and titanium in a mineral species.

W. H.

Technical Instrument Bulletin.—Vol. 3, No. 5. September, 1931. Edited by A. G. FREWIN. 16 pp., 15 text-figs. Published gratis by the Emil Busch Optical Co., Ltd., Diamond House, Hatton Garden, London, E.C. 1.

Monographs on Biochemistry. The Glycosides.—By E. F. Armstrong, D.Sc., Ph.D., LL.D., F.R.S., and K. F. Armstrong, B.A., B.Sc. 1931. 123 pp. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 12*s.* 6*d.* net.

Early Theories of Sexual Generation.—By F. J. Cole, D.Sc.Oxon., F.R.S. 1930. x + 230 pp., 21 plates and text-figs. Published by Humphrey Milford, Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 15*s.* net.

Prof. Cole scorns the method of "picking out the plums" which inspires most popular histories of science, and devotes more space to the consideration of fallacies than of discoveries. He has set out deliberately to write a complete chronicle of the growth of the Preformation Theory and of all the fallacies connected with it. Such a complete history of any scientific theory has rarely been attempted before; it emphasizes the vast mountain of labour expended in bringing forth the grain of truth, which appears so small to us because we are now so familiar with it.

The plates, which are excellent and of great historical interest, make the forgotten controversies of ovists and animalculists live again before our eyes.

The work shows the painstaking thoroughness which we have learned to expect of this author. There are a 16-page bibliography and some original translations which leave nothing to be desired in vigour and faith. L. H. J.

Life by the Seashore. An Introduction to Natural History.—By Marion Newbigin, D.Sc. Re-written and revised by Richard Elmhirst. 1931. 296 pp., 20 plates. Published by George Allen & Unwin, Ltd., 40, Museum Street, London, W.C. 1. Price 7*s.* 6*d.* net.

When it was first published, thirty years ago, Miss Newbigin's little book "caught on" at once; for its directness and simplicity made appeal, not only to the observer of shore animals who was untrained in zoological methods, but also to the university student, working on his own, who sought to supplement his laboratory studies by shore collecting and some investigation of the habits of common marine animals in their natural environment.

Since 1901 many rivals to this book have appeared, some of them much more ambitious in scope and more richly illustrated; but "Life on the Seashore" has held its own in the affections of British naturalists, and we are indebted to Mr. Elmhirst for his "attempt to prolong the life of an old friend."

We may doubt whether the re-writing to which the earlier chapters especially have been subjected improves the letterpress. Condensation of many passages has resulted in a certain loss of vitality; for one of the best features of the book in earlier editions was the vivid sense of adventure that the spontaneity of Miss Newbigin's style somehow conveyed. She wrote as an enthusiastic naturalist, and while she did her duty faithfully by the sheer systematics (in this way encouraging the amateur to feel that he was never being talked down to), she succeeded in imparting her own excitement in the discovery and observation of creatures like sea-anemones in their native habitat, where they are revealed in their full beauty only to those who know how to seek for them in the undisturbed rock-clefts still bordering our coasts.

The abbreviations to which the reviewer refers have obviously been made in order that a book of the original length shall include an elaboration of the sections

on feeding mechanisms, environmental influences, and animal and plant interdependencies. Admittedly, the serious study of such matters has advanced a long way since this book first appeared. Mr. Elmhirst has also added a chapter on British seaweeds that should prove very helpful to the shore-collector. D. L. M.

Faune de France : Mollusques terrestres et fluviatiles.—By L. GERMAIN. 1930–31. 2 vols, vi + 873 pp., 26 pls., 860 figs. Published by Paul Lechevalier, 12 Rue de Tournon, Paris. Price 300 fr.

We now have a first-rate manual of the extra-marine molluscs of France which compares favourably with any other faunistic work of this type yet published. France is known to be an excellent country for the collector. It is a place where factories can exist and yet not spoil the natural history, and it certainly produces an exceptionally large number of forms belonging to the groups in which we in England are especially interested. Those who, during the War, had to camp in France for a while know well what a paradise it is: of all countries that we have yet seen, the best worth saving from the naturalist's point of view.

Germain has adopted a view of the value of specific differences which is very nearly our own, and he has quite exceptional means of knowing the many forms which have been described during the Locardian era. We do not say that he has given us all that we could desire, but it is certain that he has made the whole world his debtors by the publication of this magnificent book. E. W. B.

Researches on Fungi.—By A. H. REGINALD BULLER, D.Sc., Ph.D., F.R.S. Vol. IV, 1931.—Further Observations on the Coprini, together with Some Investigations on Social Organization and Sex in the Hymenomycetes. xiii + 329 pp., 4 pls., 149 illustrations. Published by Longmans, Green & Co., Ltd., 39, Paternoster Row, London, E.C. 4. Price 21*s*. net.

In Part I the Coprini are discussed in detail. An account of the structure of *C. curtus* is given, and the mechanical function of giant tramal cells discussed. The periodicity of fruiting of this species and of *C. plicatilis* in daylight is described. *C. sterquilinus* must pass through the alimentary canal of the horse before germination; thus only deeply embedded spores germinate. This leads to firm fixation of the fruit body, which problem is discussed in other species. Light inhibits the development of rudimentary fruit bodies; thus only those deeply situated mature. Radial hyphæ at the base of the stipe help in fixation. Part II is devoted to social organization and the advantages that accrue to mycelia thereby. Organization of the Algæ and Plasmodiophorales is discussed. The advantage which co-operation, instead of competition, brings is seen in the Hymenomycetes. The biological significance of conjugate nuclei is pointed out, and many valuable suggestions as to the process of diploidization in higher fungi other than the Hymenomycetes are given in the light of what is known of the Coprini. P. W.

PROCEEDINGS OF THE SOCIETY.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, OCTOBER 21ST, 1931, AT 5.30 P.M., PROF. R. RUGGLES GATES, M.A., PH.D., LL.D., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

Elections to the Honorary Fellowship.—In recognition of their distinguished services rendered to Biological Science, the following gentlemen were balloted for and duly elected Honorary Fellows of the Society :—

Prof. K. Fujii, Tokyo.
Prof. Victor Grégoire, Louvain.
Prof. O. Rosenberg, Stockholm.

Nominations.—Nomination Certificates in favour of the following candidates for Ordinary Fellowship were read for the first time, and directed to be suspended in the Rooms of the Society in the usual manner :—

Sydney Boyle, F.R.P.S., Norton-on-Tees.
Peter T. Clarke, B.A., Chalfont St. Peter.
N. Ingram Hendey, M.P.S., Hillingdon.
Peter G. Mar, M.A., M.Sc., Winnipeg.
F. K. Prideaux-Brune, Dallington.
Robert Ross, M.A., Chicago.
Maximilian Wiedling, London.

Deaths were reported of :—

Maturin L. Delafield. Elected 1924.
O. T. Elliot. Elected 1899.
Samuel Glover. Elected 1912.

Votes of condolence with the relatives were passed.

Donations were reported from :—

Messrs. J. & A. Churchill—

"Recent Advances in Microscopy. Biological Applications." Edited by A. Piney.

"Elementary Histological Technique for Animal and Plant Tissues." By J. T. Holder.

Messrs. Bailliere, Tindall & Cox—

"The Regulation of Size as Illustrated in Unicellular Organisms." By E. F. Adolph.

M. Paul Lechevalier—

"Faune de France. Vol. 22, Part 2. Mollusques terrestres et fluviatiles." By Louis Germain.

M. E. Goddefroy, M.B.E., F.R.M.S.—

"Manuel de Police Technique." By E. Goddefroy.

Messrs. George Allen & Unwin, Ltd.—

"Life by the Seashore." Revised edition. By Marion Newbigin.

Messrs. Urban & Schwarzenberg—

"Mikrobiologie und Immunitätslehre." By H. Hetsch.

"Lehrbuch der Mikrophotographie und Mikroprojektion." By Kurt Laubenheimer. 2nd edition.

Trustees of the British Museum—

"Index Animalium." Parts XXIII & XXIV, 1930. By C. D. Sherborn.

Sir Robert Hadfield, Bt., F.R.M.S.—

"A Research on Faraday's 'Steels and Alloys.'"

"Notes on a Research Regarding Faraday's 'Steels and Alloys.'" By Sir Robert Hadfield.

Dr. J. A. Braxton Hicks—

78 Volumes Ray Society's Publications.

Royal Society—

£200 (Two hundred pounds).

Votes of thanks were accorded to the donors.

Exhibit.—Mr. Charles Perry exhibited and described a new monocular student's microscope and a new wide-angle binocular microscope.

A vote of thanks was accorded to Mr. Perry for his exhibit.

Papers.—The following communications were read and discussed :—

Dr. Reginald S. Clay, B.A., D.Sc., F.R.M.S., and Mr. Thomas H. Court—
"Some Early Achromatic Microscopes—Fraunhofer's Microscopes."

Dr. G. M. Findlay, O.B.E., M.D., D.Sc., F.R.M.S.—
"Virus Inclusions in Mice Livers."

Dr. Clay subsequently exhibited a Fraunhofer microscope described in his communication.

Votes of thanks were accorded to the authors of the foregoing communications, and to Dr. Clay for his exhibit and supplementary observations.

The following paper was read in title :—

Prof. J. Brontë Gatenby, B.A., D.Phil., D.Sc., F.R.M.S.—
"Acrosome Formation induced in Abraxas by Radiation and Phosphorus Poisoning."

Announcement.—The President announced that the Biological Section would meet in the Pillar Room on Wednesday, November 4th, 1931.

The proceedings then terminated.

AN ORDINARY MEETING

OF THE SOCIETY WAS HELD IN THE HASTINGS HALL, BRITISH MEDICAL ASSOCIATION HOUSE, TAVISTOCK SQUARE, LONDON, W.C. 1, ON WEDNESDAY, NOVEMBER 18TH, 1931, AT 5.30 P.M., PROF. R. RUGGLES GATES, M.A., PH.D., LL.D., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

New Fellows.—The following candidates were balloted for and duly elected Ordinary Fellows of the Society :—

Sydney Boyle, F.R.P.S., Norton-on-Tees.
Peter T. Clarke, B.A., Chalfont St. Peter.
N. Ingram Hendey, M.P.S., Hillingdon.
Peter G. Mar, M.A., M.Sc., F.C.S., Winnipeg.
F. K. Prideaux-Brune, Dallington.
Robert Ross, M.A., Chicago.
Maximilian Wiedling, London.

Nomination Certificates in favour of the following candidates were read for the first time, and ordered to be suspended in the Rooms of the Society in the usual manner :—

Francis Johns Corin, F.R.S.E., St. Ives.
Edward Hindle, M.A., Sc.D., Ph.D., London.

Donation was reported from :—

Messrs. Chapman & Hall, Ltd.—

"Elements of Optical Mineralogy." Part I. By A. N. Winchell.

A vote of thanks was accorded to the donors.

Papers.—The following communications were read and discussed :—

Mr. Conrad Beck, C.B.E., F.R.M.S.—

"The Substage Diaphragm and its Functions."

Dr. A. A. Tarkhan, M.B., B.Ch., B.Sc.—

"The Effects of Fixatives and other Reagents on Cell-size and Tissue-bulk."

Votes of thanks were accorded to the authors of the foregoing communications.

Announcement.—The President announced that the Biological Section would meet in the Pillar Room on Wednesday, December 2nd, 1931.

The proceedings then terminated.

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